PROPOSED SILICON PROJECT AT PICTON

BARRACK MINES LIMITED

Report and Recommendations
of the
Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 326 March 1988

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CONTENTS

CONTENTS
(continued)

CONTENTS
(continued)

CONTENTS
(continued)

FIGURES

TABLES

SUMMARY

In 1986 the W A Silicon Trust prepared an Environmental Review and Management Programme (ERMP) for the establishment of a silicon production process in Western Australia. The Environmental Protection Authority (EPA) assessed the proposal as environmentally acceptable, subject to commitments and recommendations outlined in EPA Bulletin 279 of May 1987.

The new owners of the project now wish to locate the charcoal retorts and silicon smelter at Picton, near Bunbury. Apart from the change of location the project has changed little, and a major reassessment of the quarrying and woodgathering operations has not been necessary. However, the new location is one in which the project could have significant environmental impacts so a detailed assessment of these impacts has been undertaken.

In response to EPA requirements, the proponent prepared a Public Environmental Report (PER) which concentrated on those aspects of the proposal which were materially changed as a result of the relocation; notably transport and the environmental impact of the combined processing facility in the Picton location.

During the public review of the PER, a public meeting was held at Eaton. At that meeting the proponent handed out a supplement to the PER which contained further information about the consideration of alternative sites. That supplement is reproduced as Appendix A of this assessment report. The proponent also made reference to a special study of air emissions which had been commissioned. That study was submitted to the EPA in early February, and is included here as Appendix B. The EPA also recieved communications from the proponent providing more information on specific issues. These are in Appendix C.

From submissions received, including oral submissions at the public meeting, and from its own investigations the EPA identified a large number of relevant environmental issues. These are listed in Appendix D, which also gives references to the place in the text in which each issue is discussed.

In its asessment of the PER the EPA has investigated all of these issues. Additional information has been sought from the proponent and independent expert advice has also been sought from the relevant Government Departments. Their responses are in Appendix E

To ensure that its assessment was as fully informed as possible, the EPA sent a Senior Environmental Officer to visit similar plants in Tasmania, and the Chairman extended a visit to the United States of America and Canada to include visits to silicon smelters in those countries. The report of the Tasmanian visit is attached as Appendix F. The report of the Chairman's American study tour is available for study at the EPA.

SPECIFIC CONCERNS

DUST

The supplementary study of amorphous silica emissions shows how the proponent could meet what it considers to be stringent standards for these emissions. There is some difference of opinion in the medical literature about the health implications of amorphous silica and silicon furnace emissions are known at times to include traces of other more toxic forms of silica. The EPA therefore considers caution appropriate, and considers the emissions produced by direct venting of the furnaces to the atmosphere unacceptable. The EPA requires a "zero direct venting" criterion for the project at the site and adherance to strict dust standards.

NOISE

The proponent has acknowledged that noise attenuation will be necessary if it is to comply with neighbourhood annoyance provisions of the noise regulations of the Environmental Protection Act, 1986. However, the proponent proposes that some noise attenuation features should only be installed after operational measurements have shown them to be necessary.

The EPA does not approve of this approach, preferring that any attenuation likely to be necessary to meet the EPA's standards should be designed-in and built-in during construction of the plant. To protect the interests of nearby residents, the EPA has recommended stringent standards to protect the nearby residents. To meet these, extensive attenuation measures and controls are likely to be necessary.

The proponent may consider these excessive, and indeed at some other location some of them may be unnecessary. However, as the assessor of developments the EPA is aware of its ongoing role in monitoring and pollution control, and of the value of "getting it right first time" as one submission put it. The EPA's noise measurements at Eaton, which are presented in Appendix H, show Eaton to be a quiet, residential suburb. Approving the plant with any lesser conditions would lead in the EPA's assessment to an unacceptable level of environmental impact and associated annoyance to local residents.

ODOUR

The wood-burning and charcoal-making activities proposed have the potential to generate offensive odours. The proponent has suggested measures to control these but the EPA considers them inadequate. The EPA has recommended changes to improve the reliability of the retort off-gas incinerator, and requires there to be no direct venting of the charcoal retorts. It has noted that it may be necessary to transport the wood waste off-site for disposal if odour from the wood waste incinerator cannot be adequately contained.

ENVIRONMENTAL AMENITY

The planning decision within the Bunbury Region Plan to zone Policy Area 5 (which includes the present site) as industrial inevitably implies changes of lifestyle for the residents of Eaton and Glen Iris. With the proposed development those changes will be noticeable.

The EPA has recommended the formation of a community consultative committee to promote communication between the proponent and the local residents. The recently announced establishment of a Bunbury office of the EPA will also aid in this regard.

ALTERNATIVE SITES

The EPA considers the assessment of alternative sites presented by the proponent in the PER and supplement superficial. As a result, with the exception of Kemerton, the EPA is not in a position to report on the environmental acceptability or otherwise of alternative sites (The EPA has recently reported on two major projects proposed to be located at Kemerton). In general terms, industrial plants located in sites with wide buffers or in remote areas can be expected to require less stringent environmental protection measures.

CONCLUSION

The EPA concludes that the project is environmentally acceptable at the proposed location and could be implemented subject to the proponent's commitments and the EPA's recommendations.

RECOMMENDATIONS

ACCEPTABILITY

Recommendation 1
The EPA concludes that the project as described in the Public Environmental Report is environmentally acceptable and recommends that it could proceed subject to the Authority's recommendations in this Assessment Report and the commitments made by the proponent about the environmental management of the project including:

- minimising noise from the Moora quarry, controlling dust, and rehabilitating the site;

- funding postgraduate research into the use of tree hollows by fauna in the jarrah forest and the impact of the project, and modifying wood collection operations if significant impacts are detected;

- screening, landscaping and draining the Picton plant site to the EPA's satisfaction, and developing a comprehensive fire suppression system and contingency plans;

- suppressing and collecting dust generated by materials conveyors;

- incinerating charcoal retort off-gases, passing furnace off-gases through a baghouse, and storing and transporting silica fume in sealed systems unless it has been pelletised;

- sampling the silica fume from furnace off-gases and submitting it to X-ray diffraction analysis to ensure that there is no crystalline silica present; and

- developing a comprehensive air, noise and waste monitoring programme for the Picton plant site.

DUST FROM THE FURNACE

Recommendation 2
The EPA recommends that the Company be required to operate under the condition that direct venting of the furnace off-gases to the atmosphere without passing them through the baghouse is not permitted at any time. (4.1.2)

Recommendation 3
The EPA recommends that the proponent be required to ensure that ground level concentrations of silica fume in the surrounding residential areas do not exceed an annual average of 0.07 mg/m^3 and a 24-hour average of 0.10 mg/m^3 at any time.(4.1.3)

NOISE CONTROL

Recommendation 4
The EPA recommends that the proponent be required to ensure that the introduced noise from the project does not cause the noise in the surrounding residential areas to exceed 50dB(A) from 0700 to 1900 hours, 45dB(A) from 1900 to 2200 hours, and 40 dB(A) from 2200 to 0700 hours. These levels should not be viewed as normal operating levels for the plant. They are the legal upper limits above which action will be taken by the EPA. These levels should be reviewed after 12 month's normal operation of the plant or earlier if recommended by the EPA..(4.2.2)

Recommendation 5
The EPA recommends that any future industrial proposal for the Picton Policy Area be referred to the EPA. (4.2.3)

Recommendation 6
The EPA recommends that from the date of release of this report until one year after commencement of normal operation of the plant any futher housing development of the residential areas surrounding the Picton Policy Area beyond that for which subdivision approval has already been given, and involving land closer to the Picton Policy Area than existing developments, should be subject to assessment by the EPA. (4.2.3)

Recommendation 7
The Company has proposed that some noise attenuation be deferred until after construction when operational measurements have proved it to be necessary. The EPA does not consider this acceptable. The Authority recommends that noise control be a fundamental design criterion, and that all attenuation considered necessary to meet EPA requirements be built-in during construction. (4.2.4)

Recommendation 8
The EPA recommends that the Company be required to submit and implement plans to the satisfaction of the EPA for the effective attenuation of noise produced by all items of plant, including:

- outdoor mobile plant;
- vehicles transporting materials to and from the site;
- sawmilling and logsplitting operations;
- feed system for the charcoal retorts;
- gas handling system for the retorts and incinerator;
- charcoal screening system;
- outdoor conveyors;
- furnace feed systems;
- stinger and taphole shotgun;
- ladle cleaning, oxygen lance and mould breaker;
- product crushing and screening systems;
- fans and ducting for the control of general dust;
- baghouse and associated fans and ducting;
- compressed air supply;
- pumps for the supply and disposal of water; and
- electrical transformer. (4.2.4)

CONTROL OF ODOURS

Recommendation 9
The EPA recommends that the proponent be required to instal and operate the charcoal retorts, the retort off-gas incinerator and the wood waste incinerator so as to guarantee that no offensive vapours or odours are detectable in residential areas adjacent to the Picton Policy Area. (4.3)

PROTECTION OF ENVIRONMENTAL AMENITY

Recommendation 10
The EPA recommends that the proponent be required to convene to the satisfaction of the EPA a community consultative committee to promote effective communication between the residents and the proponent. (4.4)

Recommendation 11
The EPA recommends that this proposal be scheduled under the definition of 'prescribed premises' in Regulations under the Environmental Protection Act 1986 for the purpose of setting fees on licences issued under the Act to more closely cover the cost to the EPA of monitoring the project. (4.4)

CONTROL OF IMPACTS DURING CONSTRUCTION

Recommendation 12
The EPA recommends that during construction of the plant the proponent and its contractors be required to:

. stabilise disturbed soil and take other appropriate measures to ensure that dust levels at the plant boundary do not exceed a 15 minute average of 1 mg/m^3;

. take appropriate short term measures to control run-off and oil spills to the satisfaction of the EPA; and

. control night time illumination to minimise its effect on residents. (5.2.7)

EFFECT OF MINING ON RARE PLANT

Recommendation 14
The EPA recommends that the proponent be required to monitor the effect of mining activities on the population of *Regelia megacephala* on the minesite with a monitoring programme approved by the EPA before mining commences. (5.4.4)

EMISSIONS FROM OTHER CARBON SOURCES

Recommendation 15
The EPA recommends that, should the proponent wish to alter its operations to use reductants other than jarrah charcoal and jarrah woodchips in a proportion greater than 15% of the total reductant charge, it should be required to present detailed management plans to the satisfaction of the EPA, outlining the likely changes in emissions and proposed control procedures. (5.6.1)

CONTROL OF WASTE WATER

Recommendation 16
The EPA recommends that the proponent be required to prepare a detailed waste water management plan to the satisfaction of the EPA, the Leschenault Inlet Management Authority and the Water Authority of WA before the commissioning of the plant. (5.6.3)

GENERAL DUST CONTROL AT PICTON SITE

Recommendation 17
The EPA recommends that during operation of the plant the proponent be required to stabilise stockpiles and unsealed access roads on the plant site and take other appropriate measures to ensure that dust levels at the plant boundary do not exceed the level specified by the EPA. This level and the associated management measures required by the EPA will be set as part of the works approval process. (5.6.6)

HANDLING OF SILICA FUME

Recommendation 18
The EPA recommends that the proponent be required to prepare and implement a plan for the management and disposal of silica fume to the satisfaction of the EPA before commissioning of the plant. (5.7.3)

VISUAL IMPACT OF PLANT

Recommendation 19

The EPA recommends that the proponent be required to prepare and implement a plan for nightime illumination of the plant and that this plan and the landscape and screening plan to which the Company is committed be required to be approved by the EPA before commissioning. (5.8.2)

1 INTRODUCTION

In September 1984 Agnew Clough Pty Ltd submitted to EPA a Notice of Intent for a proposal to establish a silicon production process in Western Australia, involving a charcoal plant at Coolup and a silicon smelter at Wundowie, treating quartzite ore mined at Moora.

That proposal was the subject of an Environmental Review and Management Programme (ERMP) prepared by the WA Silicon Trust and released by the EPA in January 1987 for a 10-week public review period. The EPA subsequently reported on the proposal, recommending that it was environmentally acceptable, subject to commitments by the proponent and additional recommendations by EPA. That assessment report, EPA Bulletin 279, was published in May 1987.

In August 1987, Barrack Mines Limited purchased the proposal from the WA Silicon Trust and shortly thereafter advised the EPA of a proposed change in location. Barrack established Barrack Silicon Pty Ltd, a wholly-owned subsidiary, which is the proponent for the present project.

Several sites were considered and eventually land at Picton was selected on which both the smelter and the charcoal plant could be located.

The proponent prepared a Public Environmental Report (PER) which was released for a 9-week public review period closing on 29 January 1988. The EPA received more than 170 submissions from the public and Government agencies. Most of these were from residents of Eaton, and one in the form of a petition was signed by 870 people most of whom were residents of Eaton, Clifton Park, Australind or Glen Iris.

On 6 January 1988, during the review period, the proponent in conjunction with the South West Development Authority, the EPA and the Department of Resources Development, held a public meeting at the Eaton Community Hall which was attended by an estimated 750 people.

The project now has four major components:

- mining quartzite ore near Moora;
- logging by the Department of Conservation and Land Management (CALM) of firewood quality jarrah from the northern jarrah forest;
- conversion of most of the wood to high purity charcoal in retorts at Picton; and
- smelting the quartzite with the charcoal and jarrah blocks in an electric arc furnace at Picton.

1.1 MINING

The mining operation is largely unchanged from that described in the ERMP. The proponent has accepted as commitments the relevant recommendations from the EPA's assessment report (EPA Bulletin No 279), and the crushed ore is now to be washed before transport to remove dust, rather than simply sprayed to surpress dust.

Location of the smelter at Picton has made rail the preferred mode of transport for the quartzite, avoiding the problems identified by the EPA in trucking the ore through Toodyay.

1.2 LOGGING

With the charcoal operation moving further south, CALM plans to change the sources of timber. Wood will still be drawn from the Harvey forest district, and the Collie district will replace the Dwellingup district as the other major supply area. Apart from this shift in sourcing, the wood supply operation is essentially unchanged.

1.3 CHARCOAL AND SMELTER OPERATIONS

The methods of operation of the charcoal retorts and the smelter furnaces are also substantially unchanged, though as the details of the project have been developed, minor changes to the structural and operational specification have been made.

1.4 ENVIRONMENTAL ISSUES

The environmental issues identified by the EPA in its consideration of the project were:

Construction
. physical disturbance to the site caused by earthworks and general building activity;
. noise from site preparation and construction activity;
. dust from earthworks and vehicle movements;
. stormwater run-off, particularly from fuel depots and workshop areas where oils may be used;
. traffic due to delivery of machinery, equipment and materials, and the arrival and departure of construction workers;
. illumination of the construction site; and
. the sociological impact, including the expected increase in employment and associated additional expenditure in the area.

Mining operation
. dust at the mine site and in transit;
. noise, especially from blasting;
. water use in relation to the limited supply and competing uses;
. disposal of washing water; and
. minesite revegetation, including attempts to preserve and protect the plant species *Regelia megacephala.*

Wood gathering operation
. alternative uses for the wood;
. impact on forest management;
. impact on other forest uses, such as tourism and the protection of fauna; and
. traffic effects on all transport routes and at the site entrance.

Charcoal production operation
. alternative reductants;
. noise from the sawmill and associated wood handling equipment including retort loading;
. stormwater drainage from the wood storage sites;
. handling of sawmill byproducts (sawdust, bark etc.);
. emissions from the wood byproduct incinerator;
. noise from the retort gas handling system;
. gaseous emissions from the retorts; and
. dust from handling charcoal.

Silicon production operation
. health implications of silica fume;
. emissions of silica fume and operation of the baghouse;
. noise from furnace feeding systems;
. noise from the baghouse and associated fans and ducts;
. noise from shotgun tapping;
. noise from ladle cleaning; and
. transport, handling and disposal of silica fume.

General
. alternative sites considered;
. visual impact of the plant;
. height considerations relative to Bunbury Airport;
. the sociological impact, including the expected increase in employment and associated additional expenditure in the area during the operational phase; and
. contingency and emergency plans.

The major issues are addressed in Section 4 of this assessment report where the EPA's research and recommendations are presented. Section 5 discusses the other impacts in the context of the submissions which raised them, the responses provided by the proponent and the EPA's consideration. Section 2 gives a brief description of the proposal, and Section 3 describes the review process associated with the EPA's assessment of the proposal.

2 DESCRIPTION OF THE PROPOSAL

2.1 MINING QUARTZITE AT MOORA

Quartzite ore of high purity is to be mined from an outcrop of the Noondine Chert on a private property 15 kilometres north of Moora. The site currently supports sparse native vegetation, including the rare plant species *Regelia megacephala* which has no common name and only occurs on the chert hills north of Moora.

The open cut quarry will operate during daylight hours only, over a period of from three to five months, to produce 60,000 tonnes of crushed ore. Operations will include drilling, blasting, screening, washing and transporting the ore. The proponent has made commitments to manage quarry operations to ensure minimum noise distrubance and dust generation.

The ore is to be washed and the proponent expects this to adequately control dust during transport and handling. This will require an estimated 3,600 litres of water per day which is to be supplied from two bores, though the proponent has undertaken to recycle extracted waters to minimise water consumption.

The total annual requirement of quartzite ore is to be produced during the winter and stockpiled railside at Moora. From there it will be transported to Picton by rail. The frequency of rail transport required will not significantly affect rail traffic density.

At Picton, there will be minimal stockpiling at railside by Westrail before delivery by road to the plant site stockpile

The proponent will develop a minesite rehabilitation plan in consultation with the Department of Mines, and seek advice from CALM on the management of *Regelia megacephala.*

2.2 LOGGING JARRAH FROM THE NORTHERN JARRAH FOREST

Firewood quality jarrah, both dry and green, standing and fallen, is to be gathered by CALM, mainly from the Harvey and Collie districts of the northern jarrah forest.

The project requires dry wood for charcoal production and this need can partly be met from existing fallen and uncut dead trees in the forest. However, these stocks of dry wood will not be sufficient for the whole requirement of the project, and green wood will be cut as part of integrated logging operations. This green wood will be stockpiled for a year on-site at Picton to allow seasoning before use.

Logs will be transported to the site by road using conventional log transport vehicles along roads already used for timber transport. An on-site docking mill will cut the wood blocks required for the charcoal retorts and the smelter.

2.3 PRODUCTION OF CHARCOAL AT PICTON

Charcoal is to be produced at Picton in two 30 metre high cylindrical retorts using hot gas from an attached furnace.

Wood fed in at the top is progressively dried out and carbonised. The pyroligneous vapours given off in this process are drawn off and burnt in the furnace along with the charcoal fines, or in an emissions incinerator.

The charcoal is air-cooled in the lower part of the retort and extracted from the base for screening and short term stockpiling.

Seasoned jarrah yields a charcoal with a low level of mineral impurities, enabling the production of silicon of very high purity.

2.4 PRODUCTION OF SILICON AT PICTON

Silicon is to be produced in two electric arc furnaces at Picton. In the process, quartzite (silicon dioxide, SiO_2) is reduced under high temperature. Charcoal is the reductant and wood blocks are added as a stabilising agent.

A distribution system will be provided to weigh the raw materials and convey them to the furnace. In addition to producing liquid silicon metal, the process generates large quantities of fine amorphous silica or 'fume' which is drawn off with the exhaust gases and filtered out in a bag house for later sale or disposal in pelletised form as land fill.

The silicon metal is tapped from the bottom of the furnace and cast into ingots. The ingots are subsequently crushed, screened, boxed and containerised for shipment. Present plans are for containers to be transported by rail to Fremantle and then shipped to overseas customers, although depending on developments the port of Bunbury could be used in the future.

3. REVIEW PROCEDURE

Public review is a most important element of the EPA's impact assessment proceedures. The EPA endeavours to ensure that proposals submitted for public review are widely publicised, so all those likely to be affected know of the proposals and have the opportunity to comment on them. In addition to press advertisements, public discussion of this proposal was encouraged by:

. a public meeting held at Eaton on 6 January 1988;

. visits by the assessment officer to some residents likely to be affected;

. lectures on the assessment process to senior students of the Eaton and Picton Primary Schools and to Bunbury Leschenault Rotary Club;

. copies of the PER were sent to organisations known to be interested;

. copies of the PER were made available for public study at
-South West Development Authority,
-Bunbury City Library both Central and Withers Branches,
-Dardanup Shire Office,
-Harvey Shire Office,
-Australind Library,
-Eaton Primary School.and
-Picton Primary School; and

. copies of the PER were available for sale from the proponent and from the South West Development Authority.

The proposal received significant coverage in the press. One popular theme even before the start of the public review was to draw inferences about the impact of the project from that of the only existing silicon smelter in Australia, at Electrona in Tasmania. That development has produced a number of environmental effects which have caused concern to some residents.

While the EPA is aware of these effects it does not consider them an inevitable part of silicon smelting. It has investigated controls which may be appropriately imposed on the Picton smelter to reduce these effects to environmentally acceptable levels.

Much of the proposal is unchanged from that addressed in the ERMP and EPA Bulletin 279. Some submissions raised issues which had already been adequately dealt with in those reports. Those issues are not further discussed here.

New issues were identified from submissions from the public and from Government bodies as well as from discussion in the media and at the public meeting. These issues have been grouped under subject headings in Appendix D and are discussed in Section 5. This should enable all who made submissions to identify the points they raised and read the EPA's consideration of them.

4. ENVIRONMENTAL IMPACTS

The list in Section 1.4 indicates that the project would have the potential for many environmental impacts. Many of these are minor or at least straight-forward, and can be readily controlled under existing regulations or licensing procedures to ensure the environmental acceptability of the project. However the project has some unique features which have required the EPA to break new ground to ensure that the environment is adequately protected.

The EPA's major concern has centred around four issues which all relate to operations at the Picton plant site:

. the emission of silica dust from the furnaces;
. the emission of noise from all parts of the plant;
. the emission of odours; and
. the change in environmental amenity for nearby residents.

The significance of dust and noise was also raised in the Wundowie ERMP but consideration of the issues was limited by a lack of specific information from the proponent. That lack has to some extent been made good in the PER and associated documents, so the EPA is now able to give these matters more detailed consideration.

4.1 EMISSION OF SILICA DUST FROM THE FURNACES

4.1.1 Health implications

The PER made reference to some difference of opinion in the medical literature over the ability of the silica dust emitted from silicon furnaces to cause the formation of fibrous scar tissue in the lungs when inhaled. Some of the differences related to:

. whether the dust was purely amorphous or whether it had traces of crystalline silica or cristobalite (both these latter two forms are known to produce fibres);
. whether the results were from tests on animals experimentally exposed to the dust or observations of humans who had had occupational exposure to the dust;
. whether the exposure was over a long or short term and at a high or low concentration; and
. whether the subjects had been affected by other lung-damaging activities like smoking.

The PER concluded that the balance of medical opinion was that amorphous silica dust was harmless, and failed to address the issue of furnace off-gases containing crystalline silica or cristobalite.

A report prepared by Dr. K. Wnekowski for the appeal hearings for the Electrona smelter came to the EPA's attention during the assessment period. This report reviewed the literature and drew the conclusion that there was rather more doubt about amorphous silica than the PER had suggested.

At the end of the review period the proponent submitted an additional report on public health implications of amorphous silica (Appendix B)

The EPA referred both these reports, along with the PER and additional proofs of evidence from consultant doctors to the Electrona appeal hearings to the Health Department for assessment.

The Health Department's reply (included in Appendix E) concludes that the additional report from the proponent adequately addresses the points raised in the Wnekowski paper, and that if the plant can operate within the proposed standards "it is unlikely that there will be any public health concerns".

With regard to the presence of crystalline silica or cristobalite in furnace off-gases, the EPA notes and endorses the proponent's commitment to submit samples of dust for X-ray crystallographic analysis to confirm that non-amorphous silica would not be present.

The EPA, having examined this aspect of the proposal, reviewed the appropriate literature and consulted the appropriate Government agencies has concluded that, provided the proponent meets its commitments and the EPA's recommendations in this report are implemented, considerations associated with silica dust emissions from the furnaces will not significantly affect public health or the environment.

4.1.2 Direct venting of the furnaces

The PER takes for granted that some direct venting of the furnace off-gases to atmosphere will occur, and estimates the extent of this venting at 50 hours per year. This is considerably less than the 200 hours per year limit placed on the Electrona smelter. However, during the review period it came to the EPA's attention that the silicon smelter at Springfield, Oregon in the United States operated under much more stringent conditions than Barrack was proposing.

With regard to the Oregon smelter, Barrack's Project Manager said at the public meeting:

> "The commitments made by that smelter to the local environmental authorities are quite stringent in terms of direct emissions, in fact their commitment is to have zero direct venting, because of the proximity of the residences."

When asked if the same could not apply to the Picton smelter, Barrack's response was:

> "As advances in silicon production technology and associated equipment are made the requirement for direct venting of silicon producing electric arc furnaces has diminished.
>
> At the present state of advancement, it is no longer necessary to direct vent silicon furnaces on a routine basis provided they are equipped with the newest baghouse facilities. Similar improvements may substantially reduce or eliminate all planned direct venting events.
>
> However, the industry (including the Oregon facility) has yet to devise systems that will eliminate the need for direct venting during emergency situations.
>
> In review of the transcript from the Eaton Public Meeting in a response to a discussion initiated by Senator Jenkins, Mr Spratt used the following phrase in relation to the Springfield Oregon plant.
>
> > 'The commitments made by that smelter to the local environmental authorities are quite stringent in terms of direct emissions, in fact their commitment is to have a zero direct venting, because of the proximity of the residences.'

In context, the commitment means that the Oregon plant does not direct vent under controllable circumstances. It most certainly does direct vent for brief periods of time during unscheduled maintenance vents or power stoppages."

This does not fully concur with the EPA's information gleaned during the Chairman's visit to the Oregon smelter and his discussions with both smelter management and the air pollution authority. The report of that visit is available for study at the EPA. In relation to direct venting this report says:

"I suppose the outstanding discovery for me today is not only the suggestion but the actuality that the plant at Springfield operates on the basis of zero venting to atmosphere and in fact venting to atmosphere is a transgression of their permit (what we would call a licence).

So, in answer to the specific question 'Is the plant operable on a zero by-pass or zero vent to atmosphere?' the answer is not only 'yes' but the answer is 'yes and Eugene does it and has done it for a long time'.

They perhaps qualified this by indicating that there may well be some circumstances when it may be environmentally desirable to in fact have direct vents to atmosphere. And that is particularly associated with start-up after a long period when the plant has been down, perhaps two days, when the change in temperature associated with start-up may cause damage to the filter bags. And of course you have to live with filter bags for some time, so it may well be appropriate under controlled conditions, with appropriate atmospheric conditions to have direct venting to atmosphere.

The conditions which may lead to venting to atmosphere are only, repeat only when and if authorised in advance on a case by case basis, by the Pollution Control Authority. This has not happened in the recent past so there has been no request for direct venting to atmosphere, and the transgressions which occurred in 1987 were not associated with venting from the baghouse."

In view of this finding the EPA considers the proposal for direct venting at Picton is inadequate, and that the baghouse system should be designed with sufficient capacity to enable operation without direct venting in all but the most extreme situations.

Recommendation 2

The EPA recommends that the Company be required to operate under the condition that direct venting of the furnace off-gases to the atmosphere without passing them through the baghouse is not permitted at any time.

4.1.3 Standards for dust emission

In the supplementary report on public health implications of silica fume the proponent has proposed operating to standards which would ensure that ground level concentrations of silica fume would not exceed an annual average of 0.07 mg/m^3 and a 24 hour average of 0.10 mg/m^3.

The first figure is derived by dividing the Australian draft occupational standard of 2 mg/m^3 by 30 to generate the proposed annual average standard. This differs from the calculation in the PER which divided the occupational health standard by 30 to produce a one-hour average. Clearly this does not "maintain consistency" as the report claims. Although the occupational standard used in the latest calculation is more stringent, the resultant figure is much less stringent as an annual average than as a one-hour average. The Health Department has studied the report and considers the proposed standard appropriate.

The second figure is taken from the World Health Organisation's guidelines for total respirable dust, and again it is endorsed by the Health Department.

In view of these endorsements, the EPA accepts the figures as appropriate public health standards to apply to the impact of the plant on the surrounding residential areas.

Recommendation 3

The EPA recommends that the proponent be required to ensure that ground level concentrations of silica fume in the surrounding residential areas do not exceed an annual average of 0.07 mg/m^3 and a 24-hour average of 0.10 mg/m^3 at any time.

It is also necessary to ensure that the environment of the industrial area is appropriately protected from exposure to silica fume.

The EPA considers that with the implementation of its Recommendations 2 and 3 and with the proper functioning of the proponent's silica fume control equipment, including the baghouse, the EPA's objectives would be met.

Appropriate conditions to ensure proper functioning of the silica fume control equipment will be set as part of works approval and licensing under the Environmental Protection Act.

4.2 NOISE

The potential for noise generation from the plant at the Picton site is of major concern to the EPA. There are many items of plant which have the potential to generate noise which could prove annoying to nearby residents. The nature of the local terrain and weather conditions also tend to transmit noise readily.

4.2.1 Background noise levels

Appendix H contains two noise studies carried out by the EPA. The first is a fourteen-day monitoring of the backgroud noise level in Eaton, measured at one of the residences closest to the plant site. The second report presents the Eaton data in comparison with data from other locations in Perth suburbs and country towns where the EPA has recently taken measurements.

The one-hour L_{90} measurement (the noise level exceeded for 90 per cent of the time over a one hour sampling period) is one commonly used method to express background noise levels. In terms of these measurements the first report shows that:

- on six nights out of fourteen the nightime background noise dropped below 30dB(A) (twice for one hour, twice for three hours, once for four hours and once for five hours);
- at no time did the background noise level exceed 50dB(A), and 45dB(A) was exceeded for only 3 per cent of the sampling period;
- for 18 per cent of the sampling period the background noise level was below 35dB(A); and
- the L_{90} background noise averaged over the fourteen-day sample period ranged from 33dB(A) at 5:00 am to just over 43dB(A) at 9:00pm.

The comparisons in the second report indicate that the noise levels in Eaton are not exceptionally low; in fact in the late night and early morning many of the other locations are quieter than Eaton. These locations were not selected for their low background noise levels but are simply those locations for which the EPA happened to have comparable data from recent measurements. Nevertheless, with these background noise levels and the plant noise levels proposed in the PER the plant is likely to be audible and potentially annoying at Eaton.

While the EPA has not taken any background noise measurements in Glen Iris or along Eaton Drive it is considered likely that noise levels in those areas would be comparable to those in Eaton or slightly lower.

4.2.2 Noise standards

This is the first major development proposed for this new industrial area at Picton, so the EPA has the advantage of being able to measure 'pre-industrial' background noise levels, and it has done so.

The area has been classified as industrial in the Bunbury Region Plan (BRP) and it is appropriate for the EPA to determine appropriate noise levels to ensure that residents of the surrounding areas are properly protected.

The EPA acknowledges that the proponent and other industries locating in the Picton Policy Area may be able to negotiate with the few nearest individual residences to attenuate their receipt of the noise rather than its generation at the plantsite. While this approach may be acceptable in individual cases it is not appropriate for the residential areas to the west, north and east of the plant site. For these the EPA considers that maximum nose levels need to be set to adequately protect the residents.

In determining an appropriate noise environment the EPA has considered the nature of Eaton as basically residential, with a primary school and a major Bunbury access road going past nearby.

The EPA has related its consideration of noise standards to the table of Assigned Outdoor Neighbourhood Noise Levels from the noise regulations under the Environmental Protection Act 1986, part of which is reproduced in Table 1. These standards are intended to be used to control noise from existing industries, not as a planning tool to set levels for new industries. Nevertheless they can provide some guidance to the maximum noise level appropriate to a range of situations.

Table 1 Assigned Outdoor Neighbourhood Noise Levels dB(A) for Category B1

Use of premises at place of reception hrs	Description of neighbourhood in which place of reception is situated	Monday-Friday 0700-1900 hrs	Monday-Friday 1900-2200 hrs W/ends & Pub.Hols 0700-2200hrs	2200-0700
Residential, educational, hospital or the like	Other residences with schools hospitals and the like or with medium density transportation	50	45	40

The EPAhas determined that Category B1, in which the place of reception of noise is used for "residential, educational, hospital purposes or the like", and the neighbourhood is "other residences with schools, hospitals and the like or with medium density transportation" is an appropriate Category.

Although Category B1 makes no mention of industry, the EPA prefers this Category as it will more appropriately protect the noise environment of these quiet areas.

The EPA's objective in controlling the noise generated by the plant is to ensure the residents of Eaton have a noise environment appropriate to a residential area. To this end the EPA recommends that noise from the industrial area be controlled to below levels based on Category B1 of the Assigned Outdoor Neighbourhood Noise Levels shown in Table 1.

Recommendation 4

The EPA recommends that the proponent be required to ensure that the introduced noise from the project does not cause the noise in the surrounding residential areas to exceed 50dB(A) from 0700 to 1900 hours, 45dB(A) from

1900 to 2200 hours, and 40 dB(A) from 2200 to 0700 hours. These levels should not be viewed as normal operating levels for the plant. They are the legal upper limits above which action will be taken by the EPA. These levels should be reviewed after 12 month's normal operation of the plant or earlier if recommended by the EPA.

The EPA notes that the proponent's predicted noise levels from the plant with "feasible noise control measures" are:

	Daytime	Night (10pm-7am)
Normal	35dB(A)	32dB(A)
Plus adverse weather (inversions)	40dB(A)	37dB(A)
With shotgun	41dB(A)	39dB(A)

Design specifications for normal operation should be significantly lower than the limits set in Recommendation 4, and this will be borne in mind by the EPA in assessing the proponent's plans for noise attenuation under Recommendation 8.

4.2.3 Other developments in and around the area

The noise impact on individuals is a consequence of the cumulative impact of developments in the industrial area. The EPA will therefore review all proposed developments in this industrial area to ensure the on-going protection of the noise environment.

Recommendation 5

The EPA recommends that any future industrial proposal for the Picton Policy Area should be referred to the EPA.

The EPA is aware of the possibility of further housing development in the surrounding residential areas closer to the industrial area, and considers such housing development inappropriate until some assessment of the noise impact of the present proposal in the industrial area can be made. It therefore recommends that all such development be subject to assessment by the EPA with a view to imposing a temporary freeze on such developments.

Recommendation 6

The EPA recommends that from the date of release of this report until one year after commencement of normal operation of the plant any futher housing development of the residential areas surrounding the Picton Policy Area beyond that for which subdivision approval has already been given, and involving land closer to the Picton Policy Area than existing developments, should be subject to assessment by the EPA.

4.2.4 Noise control measures and their installation

The noise study in the PER has suggested that noise amelioration is needed for several parts of the plant. The proponent has suggested that rather than installing some of these noise attenuation features now, noise measurements of critical items should be taken once they are installed to determine whether or not the suggested noise attenuation measures are in fact needed. The proponent believes that substantial cost savings are possible by doing this.

The EPA does not endorse the proposed approach to noise attenuation. Not only is there an unneccessary imposition on nearby residents while noise measurements are taken, the Authority considers the proposed attenuation measures minimal and expects that more will be required. There may well be problems in identifying particular items of plant and equipment causing noise, as has been the case in Electrona, causing extended annoyance to the community. In the EPA's experience post-construction noise attenuation is vastly more costly than that which can be built-in during construction. The EPA is requiring that the attenuation be inbuilt so that residents are adequately protected.

Recommendation 7

The Company has proposed that some noise attenuation be deferred until after construction when operational measurements have proved it to be necessary. The EPA does not consider this acceptable. The Authority recommends that noise control be a fundamental design criterion, and that all attenuation considered necessary to meet EPA requirements be built-in during construction.

Recommendation 8

The EPA recommends that the Company be required to submit and implement plans to the satisfaction of the EPA for the effective attenuation of noise produced by all items of plant, including:

- outdoor mobile plant;
- vehicles transporting materials to and from the site;
- sawmilling and logsplitting operations;
- feed system for the charcoal retorts;
- gas handling system for the retorts and incinerator;
- charcoal screening system;
- outdoor conveyors and furnace feed systems;
- stinger and taphole shotgun;
- ladle cleaning, oxygen lance and mould breaker;
- product crushing and screening systems;
- fans and ducting for the control of general dust;
- baghouse and associated fans and ducting;
- compressed air supply; electrical transformer; and
- pumps for the supply and disposal of water.

The EPA believes that if the proponent's commitments and the EPA's recommendations with respect to noise are fully implemented the impact of noise from the plant will be environmentally acceptable.

4.3 ODOURS

The principal source of potential odours would be the off-gases from the charcoal retorts. Unless contained these retort off-gases can be extremely offensive and irritating. In view of the proximity of residential areas, the EPA believes that they need to be fully contained. To ensure this the incinerator should have a large refractory capacity, and the proponent will need to provide an alternative fuel supply and auxiliary power supply so that the incinerator can continue to operate until the release of off gases from the retorts has ceased. It is also most important that fugitive emissions from the top of the retorts do not occur.

The incineration of wood waste also has the potential to produce unpleasant odours. If these cannot be readily contained it will probably be necessary to dispose of wood waste off site.

Recommendation 9

The EPA recommends that the proponent be required to instal and operate the charcoal retorts, the retort off-gas incinerator and the wood waste incinerator so as to guarantee that no offensive vapours or odours are detectable in residential areas adjacent to the Picton Policy Area.

If the proponent meets the above requirements the EPA considers that the project will be environmentally acceptable with regard to odours.

4.4 ENVIRONMENTAL AMENITY

The Bunbury Region Plan (BRP) with its community consultative processes established the Picton Policy Area for "general industry". This inevitably involved some change in the environmental amenity of surrounding residential areas, but the eventual establishment of the area indicates that the BRP planning process determined that the likely level of change was acceptable.

It is the function of the EPA to ensure that development does not take place in ways which substantially damage the environment or the quality of life, and the assessment process involves the placing of requirements upon industry to ensure that these are protected. However, there are differences in perception, and there will inevitably be some who oppose a development regardless of its environmental acceptability as perceived by the EPA.

The EPA is concerned that the environmental amenity of nearby residents is adequately protected and considers that this can best be achieved by a local EPA presence and by the promotion of effective communication between local residents and the proponent.

A consultative committee of local residents nominated by local residents, supported by the proponent and with access to the proponent's senior staff can help to ensure successful and productive communication channels between the proponent and the communities.

Recommendation 10

The EPA recommends that the proponent be required to convene to the satisfaction of the EPA a community consultative committee to promote effective communication between the residents and the proponent.

The EPA is required to provide services of auditing, pollution control, advice and liaison to the proponent, and accordingly the Authority seeks to set licence fees to cover at least some of those costs.

Recommendation 11

The EPA recommends that this proposal be scheduled under the definition of 'prescribed premises' in Regulations under the Environmental Protection Act 1986 for the purpose of setting fees on licences issued under the Act to more closely cover the cost to the EPA of monitoring the project.

At present these costs would be relatively high because the appropriate staff are all based in Perth and Kwinana. This project and other recent developments in the area have generated sufficient workload in the area to justify the establishment of an EPA regional office in Bunbury.

The EPA considers that if these recommendations are implemented, the environmental amenity of the surrounding residential areas will be preserved to a level consistent with the expectations of the BRP in establishing the Picton Policy Area as an industrial area.

4.5 CONCLUSIONS

While the environmental amenity of nearby residents will be affected by the proposed development, such effects were an inevitable result of the provisions of the BRP and do not constitute sufficient reason to consider the project environmentally unacceptable. The EPA's recommendations will ensure that these effects will be minimised.

The EPA concludes that the other major environmental issues of dust, noise and odours can be adequately addressed to ensure that the proposal is environmentally acceptable at the proposed location.

5. ISSUES RAISED IN SUBMISSIONS

SUBMISSION:

Why were concerns raised over the ERMP not considered?

This question was asked at the public meeting. In fact, of course, all concerns raised over the ERMP were considered in the assessment which led to Bulletin 279.

5.1 ASSESSMENT OF PROPOSED SITE

5.1.1 Zoning and planning issues

5.1.1.1 The Bunbury Region Plan

The proposed site falls within Policy Area 5A of the Bunbury Region Plan (BRP) which is shown as crosshatched in Figure 1. The boundary between the Shire of Dardanup and the City of Bunbury runs down the western edge of the proposed site which lies entirely within the Shire of Dardanup. In the EPA's experience of developments in close proximity to inter-authority boundaries, a high level of cooperation between the concerned authorities is essential in all matters affecting the impact, both pre- and post-development of a proposal.

Referring to the intended uses for the area, the Policy Statement of the Region Plan cites "general industry requiring access to port". The Plan recommends flexibility in planning for the Area and specifically mentions the need for development to satisfy environmental requirements relating to emissions of gas, dust, noise and groundwater pollutants.

By classifying the area for "general industry" the BRP foreshadowed inevitable changes in lifestyle and perception for surrounding residents. While the preparation of the BRP offered the opportunity for public input, it is likely that some of the affected residents did not react until the present project made the perceived lifestyle impacts more obvious and immediate.

SUBMISSIONS:

In or near a dust exclusion zone.
Project does not need port access.
Not a "general" industry according to Oregon contact.
A "noxious" industry.
Industry classification doesn't match area zoning.
Wrong to breach BRP guidelines with the first development.
Change "comprehensively justified" only if no more noise/dust.
BRP p51 requirement re "large stacks" asks for 2 km buffer.
A larger buffer (5 km / 10-20 km) needed.

In a reply to the Dardanup Shire which raised the questions of zoning and industry classification, and suggested that the plant was not sited according to the criteria laid down in the BRP, the proponent said:

> "Barrack Silicon Pty Ltd disputes this assertion maintaining that the classification of industries contained in the Region Plan is open to interpretation which allows the silicon plant to be sited in its proposed location and still be consistent with the Region Plan. Refer to Supplement to PER on alternative sites issued by Barrack Silicon Pty Ltd.

.....

We accept that each project must be assessed individually and that easing of perceived constraints in relation to the site must be contingent on meeting EPA conditions. Barrack is committed to meeting and where practicable exceeding environmental requirements so as to minimise the impact of the silicon plant development."

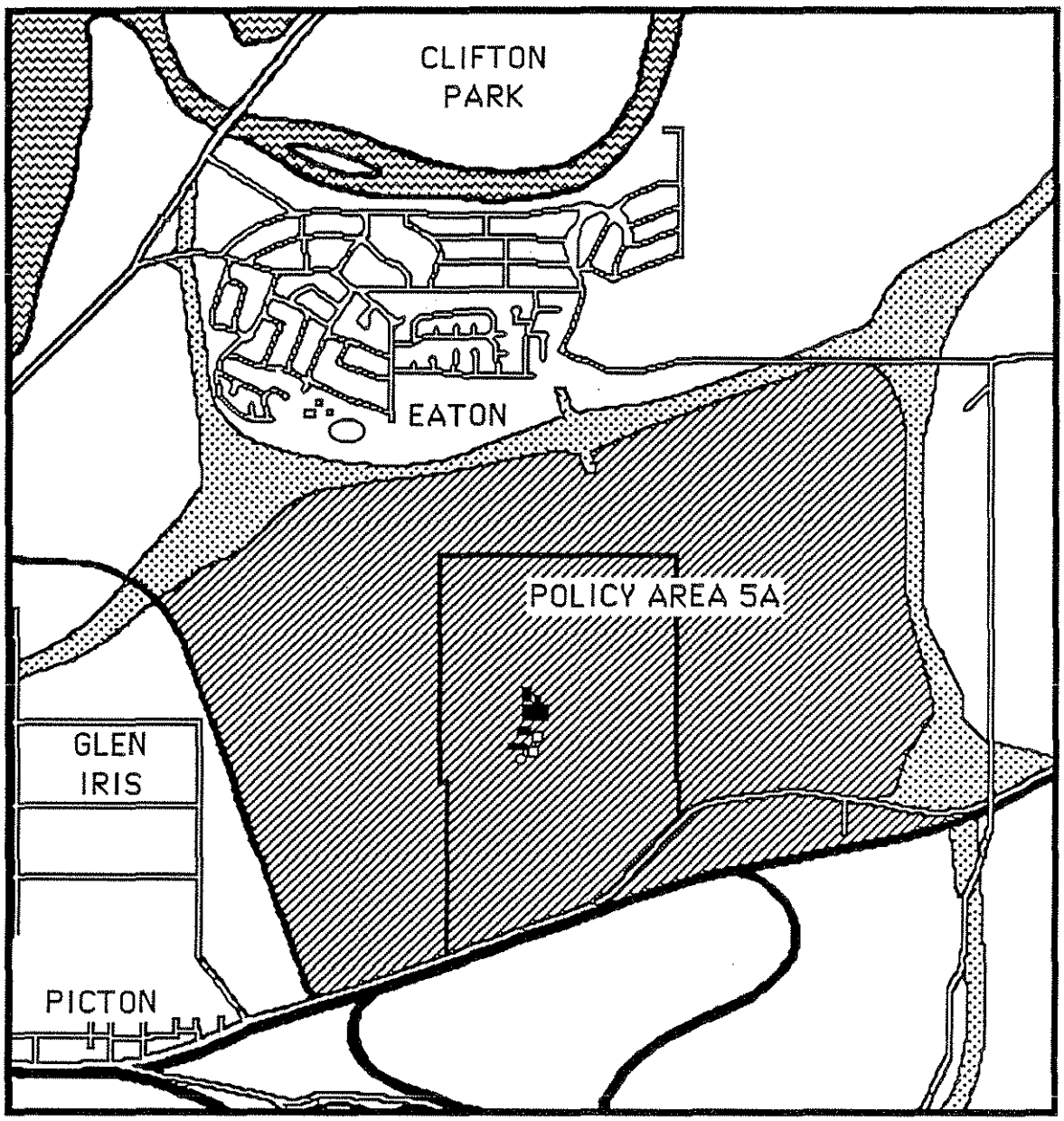

Figure 1 Policy Area 5A of the Bunbury Region Plan

The Technical Report of the Region Plan makes use of buffer zones to define where different classes of industry might appropriately go. However, it is at pains to point out that this approach, using "Rigden Lines" is "a preliminary planning tool only". On page 50 it specifically excludes smelters from this preliminary consideration, indicating that individual assessment of such major industrial projects is required. This assessment report provides the required assessment.

In view of this clear requirement of individual assessment, the EPA considers that issues of zoning, buffer size and industry classification should be considered in the context of the EPA's assessment, and that the assessment should not be bound by them.

5.1.1.2 The Structure Plan

A Structure Plan was recently prepared for this Policy Area as an industrial area.This Structure Plan was submitted to the EPA which assessed it at Divisional level and commented on it.

The State Planning Commission has recently adopted the Structure Plan and granted its consent for Amendment No 26 to the Shire of Dardanup Town Planning Scheme No 3 (zoning the land for industrial purposes) to be advertised for public submissions.

The Structure Plan was prepared with the knowledge that a silicon smelter had been proposed for the area, and the Plan makes allowance for that development. It proposes buffer zones along the northern and western boundaries of the Area, and the retention of vegetation on the higher land. A 100 metre wide belt is set aside on the southern and eastern boundaries for the planting of screening vegetation.

5.1.2 Adjacent land uses

As Figure 1 indicates, the principal adjacent land uses are residential, rural, and industrial. Immediately north of the Policy Area, and 1.5 to 2.5 kilometres from the plant site is the residential area of Eaton with a population at the 1986 census of 2,506. The Eaton development closest to the Policy Area at present is the Primary School with 370 students. Between Eaton and the Policy Area is the Australind bypass road which is presently under construction.

North of Eaton, across the Collie River in the Shire of Harvey, and over 3 kilometres from the plant site is the townsite of Clifton Park, with a population at the 1986 census of 845. Further north again is the SCM plant and beyond that the town of Australind.

West of the Policy Area is Glen Iris which is substantially rural at present, with scattered residences. This area had a population of 267 at the 1986 census. To the south of Glen Iris is the Picton light industrial area, and to the west of that residences and the Picton Primary School with 103 students.

Immediately east of the Policy Area is the route of the proposed Bunbury bypass road. Between that and Eaton Drive there is a subdivision of farmlets, thirteen of which have residences. Most of these depend on rainwater for their domestic water supplies.

To the south of the area, across the highway and the railway, the land is rural apart from the railway marshalling yards, the SECWA substation and scattered industrial developments. This area has been designated in the BRP as industrial.

To the southeast, in a thin corridor of land between the highway and the railway line are the properties closest to the proposed plant site. Closest of all is Bramleigh Poultry Farm, approximately 1 kilometre from the centre of the plant, where the owner lives on site.

The adjacent land uses are thus residential, industrial and rural. Of these the residential land use is the most environmentally sensitive, and provided that the needs of residents can be adequately taken care of, the impact of the plant on adjacent industry and rural pursuits should be acceptable.

The EPA considers the issue of the relationship between the proponent and the local communities to be of crucial importance to the general acceptance of the project and has therefore recommended the formation of a community consultative committee (Recommendation 10).

5.1.3 Access to services

As Figure 1 shows, the proposed site is adjacent to the South West Highway, the new Australind Bypass which is under construction, and the main rail line from Perth. It is also close to the Picton SECWA substation which will enable a secure power supply, and has ready access to Telecom connections.

There is no scheme water to the site, and the proposal plans to draw groundwater from the Leederville acquifer. Drainage access is available, though some upgrading may be required by the Water Authority of WA.

While the project currently proposes to use the port of Fremantle to export its product, future use of Bunbury is possible if containerised handling through that port becomes economic.

There is no rail access to the site at present, and in view of the cost of a spur line none is likely for the forseeable future. This means that the proponent's contract with Westrail for the transport of the ore from Moora will involve Westrail in offloading the ore at Picton and trucking it to the on-site stockpile.

An access road for the industrial area, part of the Structure Plan, is already under construction. Access to the site would be from this road.

5.1.4 Topography

The land covered by Policy Area 5A is relatively flat, with some swampy areas as low as 10 metres above sea level, and sandhill ridges peaking at 22 metres. The ridges are mainly wooded, and the Structure Plan for the Policy Area proposes that they remain so. One major ridge cuts across the northern end of the plant site, between the plant and the suburb of Eaton. The ridge and its vegetation will offer some visual screening and absorb some noise. Conversely, the lowlying land is often flooded in winter and at those times would reflect the sound from the plant. This also applies to land beyond the plant site in the direction of Glen Iris.

5.1.5 Meteorology

SUBMISSION:

Prevailing winds / availability of wind study.
Area subject to frequent inversions.

The PER made only passing reference to the meteorology of the area and its likely influence on the effects of noise and air emissions. Many submissions pointed out that prevailing winds are often from the south to south east, which would direct emissions over Eaton. The area is also said to be subject to frequent inversions which further increase the likely effect of emissions on surrounding residential areas.

In view of the obvious public concern, Barrack commissioned a more detailed study of airborne emissions which included an interpretation of local weather conditions.

The EPA considers that the additional study, which is presented in Appendix B of this assessment report, has adequately addressed weather considerations with regard to emissions of amorphous silica fume, but not with respect to noise.

5.1.6 Noise

5.1.6.1 Background noise levels

SUBMISSION:

Details of Eaton noise measurement not given.

The PER quotes a measurement of the nightime background noise level in Eaton of 33dB(A), but does not give full details of when and where the measurement was taken. In response to a request for this information Barrack provided the following:

> "The night-time ambient noise levels given in the PER were made on Thursday, 15th October, 1987, between 2100 and 2400 hours. During this time the temperature was 10°-12°C, relative humidity 75% with a barometer pressure of 1,023 millibars. A light southerly was blowing and there was every indication that a temperature inversion was present."

One submission criticised taking the measurement on 'late night shopping' night. The measurement did not cover the period 0100 - 0600 hours which is often the quietest period.

The EPA carried out its own measurements of background noise in Eaton. A monitoring device was installed on the roof of the garage at a house in Lofthouse Street, and operated continuously from February 9 to 23, 1988. The measurements showed that background nightime noise levels of below 30dB(A) occur quite frequently in Eaton.

SUBMISSION:

Noise study doesn't mention noise levels at Glen Iris.

In fact the noise study (Appendix C of the PER) includes nightime ambient noise levels measured in Glen Iris at a point just south of Treasure Road and west of the railway line to the port. The discussion in the study and in the PER mainly refers to Eaton, but the EPA's recommendation with regard to introduced noise (Recommendation 4) applies equally to Glen Iris and other areas surrounding the proposed plant site.

5.1.6.2 The Noise Category of Eaton

The Noise Analysis in Appendix C of the PER, referring to the township of Eaton said:

> "To categorise this area in terms of the Noise Abatement Regulations it would best seem to fit category A2 which has an assigned outdoor noise level of 35dB(A) (2200-0700 hours).
>
> The imminent Australind by-pass road system would change the category to B1 being 40dB(A)."

The relevant table in the Noise Abatement Regulations relates category A2 to a "residential, domestic or private recreational" place of reception in a neighbourhood with "only or predominantly residences, with infrequent transportation". Category B1 is related to a place of reception which is "residential , educational, hospital or the like" in a neighbourhood of "other residences with schools, hospitals and the like or with medium density transportation".

One submission claimed that to sustain a B1 assigned noise classification on the basis of transportation, as implied in the above quotation, would require medium density transportation on the bypass road during 2200 - 0700 hours which, it claimed, was most unlikely. It suggested that an A2 classification was more appropriate.

SUBMISSION:

> Night time noise from bypass road too low for B1 category.

In reply Barrack said:-

> "The type of category appropriate to an area is defined by the principal activities with 200m radius of the point at which noise levels are measured. Category A-2 is for residences with only or predominantly residences and infrequent transportation in this area. Category B-I is for residences with other residences and schools, hospitals or the like or with medium density transportation. There are likely to be residences in both of these categories at Eaton but those closest to the plant site are also likely to be close to the primary school and therefore will be Category B-I."

The existing noise regulations were introduced to control noise from existing sources, and were not intended for planning purposes. For the purpose of this industrial area the EPA has recommended appropriate noise levels in the surrounding residential areas which should be adhered to by industries locating within the industrial area. Noises to be introduced into the area should also be assessed in terms of characteristics such as tonality, and appropriate considerations made in determining the noise level.

5.1.6.3 Other noise issues

SUBMISSION:

From what point are the noise contours measured?

Barrack's response was:

"The centre point of the furnace house."

SUBMISSION:

Concern that noise will be annoying.

In Recommendation 4 the EPA has proposed noise levels which should not be exceeded by noises introduced by the Company into the adjacent residential areas. If these levels are adhered to there should be no significant noise annoyance.

SUBMISSION:

The noise study was inadequate.

The EPA is aware that the information on noise provided in the PER is preliminary, and that more complete and final information is necessary before noise issues can be fully addressed. For this reason it has recommended that several aspects of noise control be dealt with as part of the works approval process. The EPA has identified several areas in which the noise study may have underestimated likely noise propogation, and has conveyed these inadequacies to the Company. If the project proceeds, the recommendations elsewhere in this report with regard to introduced noise levels should ensure acceptability, regardless of the PER noise study.

SUBMISSIONS:

Eaton residents hear noises from long distances away.
Swamps between plant and Glen Iris will reflect noise.
Noise will be distracting to school children.
Reduced noise level after 10 pm - children in bed before then.

These additional points raised in submissions were considered by the EPA in setting the noise levels to apply in residential areas adjacent to the Picton Policy Area.

5.1.7 Environmental amenity

The BRP, by classifying the Picton Policy Area for 'general industry' inevitably changed the quality of life for surrounding residents. While some of the aspects of the plant's appearance and operation are environmental, and the subject of this assessment, the mere presence of the plant is not. The EPA does not consider changes in lifestyle perception based solely on the fact that the plant "is there" as relevant to its assessment of environmental acceptability.

SUBMISSIONS:

People are more important than siting costs.
Eaton is beautiful, don't spoil it or the lifestyle.
Undefined fears or apprehensions about the plant.
Chose Eaton not Australind to avoid SCM.
Too close.
Too close to school.
We were here first!

The proponent's Project Manager addressed some of these issues in a reply to a letter from some Eaton residents:

> "I would agree that Eaton is a lovely quiet community, in which anyone would be pleased to reside. As the father of four, I also appreciate the communities deep interest in preserving the Eaton environment as a family oriented development. It is certainly not my intent - nor that of Barrack Silicon Pty Ltd - to create a nuisance (or havoc as some would have it) upon Eaton. As time goes by, I would expect many Barrack employees to be attracted to Eaton due to its proximity to their place of work."

To the extent that the concerns expressed in these submissions are related the measurable effects of the project such as dust, noise and odours, the EPA believes that these effects can be kept to environmentally acceptable levels. To help to ensure this, and to promote effective and positive communication between the residents and the proponent the formation of a community consultative committee is recommended (Recommendation 10).

SUBMISSION:

Property values will be reduced.

This is not an issue directly related to environmental assessment. Nevertheless, the EPA referred it to the proponent because of the many submission raising the issue, and the proponent has provided the following response:

> "Although Barrack Silicon Pty Ltd would not pretend to be an authoritative observer of real estate values at Eaton, or elsewhere, the company does not accept the premise that its presence will impact adversely on Eaton real estate values.
>
> The presence of the Barrack Project may ultimately enhance Eaton real estate values as job opportunities at the plant will attract employees to locate closer to their work place.
>
> Apparently this attraction is not an unusual phenomena, for D T Rigden in his 1977 report to the Public Health Department notes, 'Complaints from the public about emissions from industry frequently occur because houses are allowed to be built too close to existing industry; industries have also been built too close to existing residential areas, but the attraction of houses to industrial areas has been a far greater world wide problem.'"

5.1.8 Alternative sites

The present proponent and its predecessors have investigated numerous sites for the charcoal retorts and the smelter furnaces. Details of some of the sites considered are given in the ERMP. In considering the Picton location several possible sites were examined and eventually rejected. Some are discussed in the PER, and some in a supplement to the PER (Appendix A) distributed at the public meeting.

Some submissions considered the consideration of alternative sites inadequate. The EPA would agree that on the basis of the published analysis some sites have been rejected on inadequate grounds. While the Government did encourage the proponent to consider the present site, a proper environmental assessment requires full consideration of realistic alternative sites. This is especially true in the present case, where the chosen site presents some environmental difficulties, and there are several alternative sites with significant advantages.

These views were supported by the submission from the State Planning Commission (SPC) which said:

> "Concern is however raised over the analysis of alternative sites, especially those that would be clearly located within a heavy industry classification. Given the substantial public opposition to the project on the present site and some doubts about the environmental acceptability of particularly noise and dust emissions, it would seem appropriate to fully investigate alternative sites. Such a planning study should establish the costs to society over time of any likely adverse impacts. These costs may be significantly higher than the extra short term costs associated with an alternative site."

SUBMISSION:

How is the project "too well advanced" to shift?

In the press Barrack's Project Manager was quoted as saying that the project was too well advanced to shift. Submissions took issue with this and asked how this could be so unless the proponent had pre-empted the EPA's decision. The proponent's reply was:

> "The EPA has been given great authority by the State Government, and established in such a manner that it stands independently from all other Governmental Departmental, Industry, and the public in general. EPA decisions can not be pre-empted."

Submissions suggested many alternative sites. The reasons given by the proponent for rejecting them are summarised below:

KWINANA

Barrack:- Distant from the forests; for on-going security of power supply the proponent was directed further south.

WAGERUP, WORSLEY

Barrack: Farther from construction workforce than other options.

In response to this, some submissions said:

SUBMISSION:

Barrack can establish 20-30 km from town as Worsley have.

KEMERTON

Barrack: Slightly more distant from wood source than Picton.

Several sumissions took issue with this, based on the supply information in the PER:

SUBMISSION:

Most blocks shown in Figure 6.1 of the PER are closer to Kemerton than Picton.

Kemerton is also more distant from existing rail connections, but submissions noted that the present plans for ore transport made this issue relatively insignificant:

SUBMISSION:

Trucking ore from rail to site, so no need to be near rail.

The EPA agrees with these arguments and considers that the arguments given by the proponent for rejecting the Kemerton site may have been incomplete.

THE PICTON 'WEDGE'

Submissions suggested a number of sites near to existing industries in the Picton "wedge" close to Picton. The proponent gave specific consideration to many of these:

Davenport Too close to Bunbury Airport for the height of buildings required.

Land near Picton, between Preston and Ferguson Rivers Unsuitable because of the flight path and radio interference constraints of Bunbury airport.

Land between South Western Highway and Ferguson River Unsuitable because of the flight path and radio interference constraints of Bunbury airport.

The EPA's independent assessment of height restrictions for Bunbury Airport in Section 5.8.3 confirms these conclusions.

Land within the rail loop Area too small and restrictive.

The EPA's on-site inspection confirms that this site could prove restrictive, especially if the proponent's hopes for expansion eventuate. On that score, however, the EPA considers the present site is also likely to prove restrictive for expansion.

Land to the south and east of the rail loop Too lowlying and wet, with swamps and soaks overlying organic sediments

One submission took issue with this assessment, and after consulting a local boring contractor claimed:

SUBMISSION:

The only organic sediments would be at the surface and could be easily removed.

There was also the suggestion that this land may have been constrained by airport height restrictions. The EPA's investigations show that this is not the case. If the airport runway were extended to the maximum (to the Preston River), the height restriction for the plant at this location would be approximately 66 metres. With the present runway, the restriction is over 80 metres. In fact this site and the present site are approximately equidistant from the airport so the height restrictions are the same for both sites.

Another submission was concerned with public perceptions of this site:

SUBMISSION:

Residents would think SE of rail loop is still too close.

The EPA does not necessarily agree with this assessment, and while acknowledging the likelihood of greater site costs at this location, considers that the reasons given by the proponent for rejecting this site may have been incomplete.

ALONG THE PICTON-MUJA POWER LINE

One submission pointed out that with respect to power supply, any location along the Picton-Muja 132kV line would be satisfactory, and another proposed such a site on the foothills of the scarp. This site has a number of advantages, but its relatively high elevation means that the plant could be seen from Bunbury, 16 kilometres away, which may not be ideal.

COLLIE

Collie, at the other end of the power line is another alternative. No specific sites were suggested, and the proponent has not provided any assessment of sites at Collie.

WUNDOWIE/COOLUP

The proponent already has EPA approval to locate the smelters at Wundowie, and the charcoal retorts at Coolup. Several submissions pointed out that the residents of Wundowie "want it", and one reported the results of a mail survey which indicated overwhelming support for the location of the smelter there. However, the EPA does not consider the Wundowie site well suited to the project and would not dissuade the proponent from looking elsewhere.

A combined operation at Coolup is a possibility the proponent did consider. The site was found to have wood transport advantages but power supply delays and difficulties.

5.2 CONSTRUCTION OF THE PLANT

Neither the PER nor the ERMP discusses the likely environmental impacts of the construction phase of the project. These can be significant, and need to be appropriately managed.

5.2.1 Disturbance to the site

Construction operations are likely to lead to disturbance of the site beyond the immediate area of the plant buildings and stockpile areas.

The site has some problems with regard to a high water table, and these will be marginally increased by the removal of vegetation.

SUBMISSION:

Little biological information about site in PER.
Why was a preliminary flora assessment acceptable?

The site has been used for grazing animals for many years, so the uncleared land was certainly not unspoilt bush. It was not therefore considered necessary to undertake a detailed biological assessment of the site. However, the wooded areas will provide useful screening and noise attenuation. They are also frequented by wildlife, and it is likely that the construction operations will disturb them.

The PER acknowledges this, and on page 45 the Company makes a commitment to "encourage the retention of existing trees and shrubs ... to maintain, as much as possible, the original character of the site." On page 50 it notes that its landscaping of areas now pastured will provide additional trees for birds on the site.

5.2.2 Noise

SUBMISSION:

Excessive noise is likely during construction.

Machinery used during the construction phase will include large earthmoving equipment and other mobile equipment which is both noisy in operation and fitted with noisy reversing indicators. Other construction equipment such as compressors and small tools will also generate noise. It is possible that the contractors may wish to operate day and night and this will have added implications for the impact of the noise generated. The EPA's recommendations with regard to acceptable noise levels in the adjacent residential areas apply to the construction phase.

5.2.3 Dust

The site works for the plant and stockpiles will require substantial earthworks which will generate dust. Prevailing winds will tend to carry this dust over adjacent residential areas.

5.2.4 Stormwater run-off

Construction will continue over periods when rainstorms and showers are likely and run-off will probably be generated before the appropriate long term means for handling it are in place. The construction equipment also has the potential to generate oil spills and the like in areas where these cannot be properly contained.

5.2.5 Traffic

Traffic related to construction will differ from that generated by the normal operation of the plant. A larger number of workers will be commuting to the site, but there will probably be fewer trucks; although some of these will bear oversized loads.

5.2.6 Illumination

If the construction is to continue day and night, illumination will be required. This will be visible from South Western Highway, since screening vegetation will not have had time to grow, and may be annoying to nearby residents.

5.2.7 Sociological impact

The employment and commercial opportunities provided by the construction of the plant will be of benefit to the Bunbury Region in general and to a lesser extent to the industries and residents of the immediate vicinity. Nevertheless, the public meeting provided ample evidence of disaffection with the smelter, and this feeling would be hardened as construction proceeded. This would likely be evidenced in a higher level of complaints about the construction activites than might otherwise be expected.

Recommendation 12

The EPA recommends that during construction of the plant the proponent and its contractors be required to:-

- stabilise disturbed soil and take other appropriate measures to ensure that dust levels at the plant boundary do not exceed a 15 minute average of 1 mg/m^3;
- take appropriate short-term measures to control run-off and oil spills to the satisfaction of the EPA; and
- control night time illumination to minimise its effect on residents.

5.3 COMMISSIONING THE PLANT

5.3.1 Noise

The noise study in the PER has suggested that noise amelioration is needed for some or all of :

. mobile equipment;
. docking plant building;
. furnace building;
. ladle cleaning;
. crusher and screen building; and
. shotgun.

The above list does not include the baghouse fans which have proved, in the case of Electrona, to be a major source of noise emission.

SUBMISSION:

Excessive noise is likely during commissioning.
Disagree with not implementing full noise contol at once.

The EPA agrees with these submissions, and does not endorse the proposed approach to noise attenuation. The EPA's recommendations require the installation during construction of all attenuation measures likely to be necessary to meet the EPA's standards. This attenuation will therefore be in place during commissioning, removing the concern over excessive noise.

5.3.2 Dust

SUBMISSION:

Likely to be problems with dust during commissioning.

The PER does not discuss the likely environmental impacts during commissioning except in relation to the proposed noise measurements mentioned above. However, information from the commissioning of the silicon smelter in Electrona, Tasmania suggests that during commissioning the furnace is often subject to instability.

At such times the furnace off-gases are much hotter than normal and if the baghouse has not been designed with sufficient surplus capacity to handle the extra volume of cooling air required, the baghouse must be bypassed to avoid burning out the bags.

The EPA understands that this led to significant bypassing of the baghouse at Electrona. Obviously a baghouse design which ensured that this was not neccessary in all but the most extreme situations would be environmentally preferable. The EPA makes specific recommendations that there be no direct venting and by implication requires the proponent to provide a baghouse with the necessary extra capacity to make that possible without burning out bags.

5.4 MINING OPERATIONS

5.4.1 Dust

The PER refers to the discussion of this issue in the ERMP, adding a general commitment to employ normal operating practices to minimise dust generation from within the minesite. The issue was not raised in submissions, and the EPA considers the proponent's commitments in Appendix G of this assessment report satisfactory.

5.4.2 Noise

In addition to the commitments in the ERMP the PER offers the commitment that the quarrying will be managed to ensure minimum noise disturbance. The issue was not raised in submissions, and the EPA considers the proponent's commitments in Appendix G of this assessment report satisfactory.

5.4.3 Water use

The proponent has revised its water requirements at the minesite downwards from 2,200m^3 in the ERMP to 3,600 litres (3.6 m^3) in the PER. The Department of Mines has confirmed that "adequate supplies of quartzite and ground water are available at Moora". This issue was not raised in submissions, and the EPA considers the proponent's commitments in Appendix G of this assessment report satisfactory.

5.4.4 Minesite revegetation

SUBMISSION:

Concern over regeneration of *Regelia megacephala.*

One submission raised the issue of the rare plant *Regelia megacephala*, claiming that the PER gave insufficient information about the proposed regeneration of the plant and monitoring of how it was affected by mining.

In its assessment of the Wundowie ERMP the EPA recommended that the proponent should resurvey the vegetation on the minesite, prepare a management and rehabilitation plan and submit it to the Mines Department for approval.

While the PER has little detail on regeneration of *Regelia megacephala* , the proponent has made commitments to complete site rehabilitaion to the satisfaction of the Department of Mines, using local native vegetation where practicable, and to seek advice from CALM on the regeneration of the plant. The Department of Mines considers these commitments satisfactory.

The EPA acknowledges the significance of *Regelia megacephala* and agrees that monitoring of the population on the minesite is appropriate to ensure that any negative effects of the mining activity on the plant population can be measured and appropriate actions determined.

Recommendation 13

The EPA recommends that the proponent be required to monitor the effect of mining activities on the population of *Regelia megacephala* on the minesite with a monitoring programme approved by the EPA before mining commences.

5.4.5 Transport of ore

Because of the change of location from Wundowie to Picton it has become feasible to use rail transport for the greater part of the journey. As indicated in Bulletin 279, the EPA saw problems associated with the road transport proposed in the ERMP and it greatly prefers the rail transport proposals outlined in the PER. Because of the changes in transport, the EPA's recommendation in Bulletin 279 with respect to transport through Toodyay is no longer relevant.

However, the off-loading and road transport required at Picton have two important implications. Firstly it is essential that the proponent's commitment to wash the ore prior to transportation is adhered to; and secondly, the advantage of the plant being located adjacent to rail transport is insignificant. Also while the proponent may contract Westrail to transport the ore, that transportation, including stockpiling at Picton must be approved by the EPA.

SUBMISSION:

No detail of ore transport from Picton railhead to plantsite.

Barrack's repy was:

> "The movement of quartzite product from the Moora railhead stockpile to railcars, and from railcars at Picton Junction to the plant stockpile is a contract responsibility of Westrail. Westrail will be held responsible under that contract to move the ore employing standard acceptable dust surpression techniques (most probably water sprays).
>
> In general comment, the quartzite product under discussion will be coarse grained (> 25mm) freshly crushed material which will be subjected to severe wet screening and vibration under spray conditions to remove dust and fine fractions at the mine site.
>
> The final product is very hard, abrasive, dust free; and has a great resistance to further degradation via transhandling equipment."

The EPA acknowledges the nature of the material, and approves of the change to a washed and virtually dust-free product leaving the mine site. Nevertheless the transport of the ore from railcars at Picton to the plant site has other environmental significance including the management of water used for dust control at the railside stockpile, and the traffic effect of the road transport used.

Westrail in its submission to the EPA said:

> "Westrail, in order to achieve a door-to-door transport task will have to construct a rail siding at .... Picton (adjacent to the smelter complex).
>
> The transport of the above mentioned product will be carried out under transport regulations as set down and in accordance with the Environmental Protection Authority guide lines."

5.5 WOOD GATHERING OPERATIONS

5.5.1 Alternative uses for the wood

SUBMISSION:

What provisions will be made to guarantee domestic firewood? Cottage industry using dead jarrah for fine furniture will suffer.

At the Eaton public meeting an officer from CALM stated:

> "There are areas in the logging plans that are being prepared for this project, should it go ahead, where blocks of forest are going to be set aside separate from this project close to Bunbury and other centres like Harvey, where commercial firewood operators will be operating."

These questions were also specifically referred to CALM by the EPA. The reply from the Chief Executive Officer of CALM, reproduced in Appendix E, states:

> **"Use of domestic firewood**
> CALM obtains monthly figures of licences issued to commercial firewood operators and also returns from sawmills advising how much firewood was sold from mill residues. As part of the Timber Strategy, discussions were held with the Solid Fuel Merchants Association and other firewood cutters and estimates were made as a result of these discussions.
>
> Domestic firewood requirements for the metropolitan area will be met from forest areas north of the Murray River. Firewood resource from this area has not been counted in assessing the resource available for the silicon project.
>
> Designated public firewood areas have been set aside and are publicised. In the Bunbury/Harvey area specific forest blocks have been set aside for firewood and will not be made available to the silicon project.
>
> **Cottage industry using dead jarrah**
> Licences issued by the department to date are for volumes in the tens of cubic metres.
>
> While I have not heard of a proposal to make dead jarrah into fine furniture, there would be ample scope to produce large quantities of wood from areas not covered by the proposed project."

In addition CALM has given clear assurances below that available supplies are far in excess of demand. It is clearly CALM's belief that the wood intended for the project does not have an alternative use, because it is vastly in excess of what is required for domestic firewood, fine furniture and fenceposts. It would otherwise remain in the forest with a negative impact on forest management.

5.5.2 Impact on forest management

The EPA received a submission from CALM (reproduced in Appendix E) which addressed the general area of forest management in relation to the project in these terms:

> "Management plans for all CALM land are a requirement of the CALM Act. These plans set out the issues in each area and describe how CALM proposes to address them, together with management guidelines and policies currently in use. Accountability for field performance is the responsibility of the Operations Directorate of the Department.
>
> The area of forest from which timber supplies will be drawn for the proposed charcoal production facility is covered by the Central Forest Region Plan and by the State Timber supply strategy. These documents were approved by the Minister for Conservation and Land Management on 18 December 1987.
>
> A feature of the jarrah forest is the large resource of timber which is below sawlog specification and which presents serious problems for forest management. Availability of a market for this poor quality material would have the effect of greatly facilitating efficient regeneration of cut over forest, of increasing the efficiency of utilisation of timber harvested and of increasing the growth rate of the whole forest. Utilisation of this previously unsaleable resource also has a positive economic advantage to the State. It is important to note that the costs to the proponent of delivery of firewood logs to the charcoal plant will include all "in-forest" costs of administration of the operation, and a charge to cover their share of road construction costs. Some additional staff will be required to ensure that firewood logs of the required specification are provided to the plant.
>
> The CALM Act also sets out a clear objective for the forest as a whole to be managed on a sustained yield basis. This is reflected in the forest management guidelines which state that the aim of management is to 'adjust the cut from the native forest progressively to a level consistent with the growth of the forest ....'.
>
> The sustainability of the timber yield from the forest is further considered under Resources, below, but sustainability can also be considered from the viewpoint of maintaining the jarrah forest ecosystem itself. This has been ensured in two ways; 34% of the forest is in secure reserves, which will remain uncut and intensive, long-term research is proceeding to ensure the forests continued productivity. "

5.5.2.1 Supply capacity

SUBMISSION:

CALM Region Management Plan doesn't specifically cover this project.

Since the project has not yet been approved it would be highly improper for it to be specifically included in CALM's plans as a fait accompli. The relevant question is whether the forest can supply the project in an environmentally acceptable way.

SUBMISSION:

Doubt that the forest can supply that much firewood.
What about the long-term wood supply?

CALM in its submission commented on its estimation of the available resouce:

> "CALM carries out periodic broad scale Resource Level Inventories (RLI) over the jarrah forest, recording the volume of sawlogs, firewood and regrowth by species. Although the inventory is based on a sample of only about 0.6% of the area, it is statistically valid over the forest as a whole.
>
> In addition to the RLI, a Management Level Inventory (MLI) is carried out on individual logging coupes to provide more precise data for the rolling five year logging plans. These rolling plans are updated annually.
>
> The firewood resource data in the P.E.R. combine both MLI and RLI figures to develop a summary. It has been of concern to CALM that the RLI data are over 10 years old, and did not assess the firewood resource according to the specification of the Silicon project. However, re-evaluation and field inspections with the proponent have confirmed there is adequate resource of firewood available for the life of the project in the Harvey, Collie, Busselton, Nannup and Kirup districts. The principal difference in firewood availability caused by shifting the focus of the project to Picton, is that the dry firewood component (trees already dead) is more scattered and has a longer haulage factor than for the Coolup site.
>
> The Public Environmental Report states (p.35) that over two thirds of the resource will come from the Harvey District and one third from Collie District. While in some years of the operation this may prove to be correct, in order to make maximum use of available green and dry firewood, especially in the north western part of Kirup District, CALM reserves the right to draw on all forest areas within the same general radius of Picton including the Donnybrook Sunkland and Kirup District. "

Commenting further on the adequacy of the available supply, an officer from CALM said at the public meeting:

> "Regarding the timber for the plant, our assessments show that within a 70 kilometre radius of the proposed site there is approximately twice as much timber as required to fill the State Agreement at the rate that is being approved. Furthermore, there is approximately twice that amount again of the specification of timber of a lower quality than is what is at present agreed. "

SUBMISSION:

Regenerative capacity of some forest blocks doubted.

This question was referred to CALM. In reply CALM said that it did not agree that the regenerative capacity of the blocks referred to should be seiously questioned, and went on to point out that:

> "Areas harvested to provide wood for the project will actually have their regenerative potential increased because large old previously unmerchantable trees will now be able to be removed allowing space for new trees to grow."

SUBMISSION:

Won't most dead timber have termites?

CALM's reply to this was:

> "Termites are not acceptable in the timber to be supplied. Assessments to confirm that there is ample resource available to the project have not counted termite affected timber."

On the basis of these assurances from CALM the EPA is satisfied that there is sufficient wood of the required quality to supply the project.

5.5.2.2 Disease

SUBMISSION:

What procedures will be used to prevent spread of dieback?

CALM in its submission provided the following information:

> "The planning and performance of all forest operations in the jarrah forest are dominated by the requirements for the prevention of further infection due to the soil fungus *Phytophthora cinnamomi.* The requirements for protection of forest from the disease, and for handling areas already infected are spelt out in greater detail in field operations manuals, and the Department's policy statements.
>
> The harvesting of firewood for the Project would be subject to the same stringent controls as are applied to all other timber harvesting activities. It has been made quite clear to the proponent that they will receive no concessions at all in this respect.
>
> On this basis the Project will not result in an increased potential to spread the disease. "

The EPA considers that the greatest expertise and experience with the control of dieback is in CALM and that therefore the responsibility should also reside there.

SUBMISSION:

Some dieback-affected blocks not shown as such in PER map.

CALM's reply to this comment was:

> "Dieback does not affect a whole forest block, so it is an oversimplification to say whether a block is affected or not affected by dieback. It is unlikely that any forest block in the western part of the jarrah forest is totally free from dieback. The department has figures for all the resource in each of the Collie, Harvey and Kirup districts."

SUBMISSION:

What controls will be used to stop dieback spread from stockpile drainage?

Barrack replied that :

> "the possibility of dieback being transferred to the plant site will be considered and CALM will be asked to advise on a dieback monitoring programme for site run-off.
>
> The proponents consider that the risk is small as no particular run-off control measures are in force at timber mills in the south-west including those that are sited in or adjacent to forest areas."

CALM pointed out that water from the stockpile area "will not be allowed to disperse into adjacent areas."

Finally the timber supplied will not include roots and will have minimal soil adhering. As conditions during transport and storage on site will be relatively unfavourable for the fungus, the EPA considers that the likelihood of the spread of dieback from the stockpile drainage is minimal, and makes no specific recommendation.

5.5.2.3 Other impacts on the forest

SUBMISSION:

What effect will the project have on the nutrient cycle?

The submission from CALM states:

> "Research published by Hingston et al from CSIRO gives estimates of the available nutrient pool on typical jarrah forest sites and confirms that jarrah grows in extremely infertile sites. These facts are confirmed by the low nutrient element content of the timber and is the very reason why jarrah charcoal is attractive for the production of high grade Silicon it contains very low levels of chemical "impurities".
>
> The Silicon project will therefore not have a significant impact on the nutrient capital of the forests. "

SUBMISSION:

Project will change forest into a silvicultural plantation.

The EPA acknowledges that there is a difference in environmental terms between virgin jarrah forest and jarrah forest managed for maximum timber production. As mentioned by CALM above, 34% of the forest is held in reserves which are not logged.

Nevertheless, as implied above the EPA is interested in the maintenance of the jarrah forest ecosystem throughout the jarrah forest, not just within these reserves. For these reasons the EPA is concerned that this project should not lead to the removal of an excessive proportion of the standing forest to the detriment of the ecosystem.

SUBMISSION:

Unless Barrack take mostly (75%) green, there is little benefit for forest.

The precise details of the agreement between Barrack and CALM are not yet finalised. However, the EPA understands that the responsibility for management of the forest belongs to CALM, and it is obviously in CALM's interests to maximise the proportion of green wood, subject to that agreement. CALM's submission makes the following points:

> "The principal difference in firewood availability caused by shifting the focus of the project to Picton, is that the dry firewood component (trees already dead) is more scattered and has a longer haulage factor than for the Coolup site.
>
> The old, unmarketable and often quite large trees which can be removed as green firewood have prevented efficient regeneration and achievement of maximum potential increment in selection cut forest.
>
> Their removal would be a major advance in silviculture of the jarrah forest.. For the first time, complete regeneration of cutover forest will be possible. (It should also be noted that removal of dead (dry) trees only has virtually no beneficial effect on the forest or its regeneration).
>
> Page 39 of the P.E.R. stresses the Company's reliance on dry timber being supplied for the first 5 years. While this is obviously desirable from the proponent's viewpoint, as timber must be dry to optimise charcoal production, it is not in the best interests of overall forest management for dry timber only, to be produced. It has always been CALM's intention that supply of timber for the charcoal production facility would be integrated with other logging operations in order to achieve operational efficiency and economy, as well as silvicultural benefit. This means that existing logging operations, in addition to supplying sawlogs, poles, mining timber etc, will now harvest dead trees and live, previously unmarketable trees, from the same logging coupes. The proportion of dry and green firewood to be supplied in any period will be included in detailed logging plans prepared by the Department on an annual basis, in consultation with the Company.

As the resource obtainable from these integrated operations will be only about 50% of dry wood, the project will be supplemented by a separate operation confined to areas of forest severely affected by dieback, and where the majority of trees would be dead or dying. This operation will enable valuable rehabilitation work to be carried out in conjunction with or soon after logging. "

CALM's direct response to the question raised in the submission was:

"It is true that the sale of green residue will have a greater benefit to general forest management than purely harvesting dead residue. Assessments have shown that there are approximately equal amounts of dead and green firewood available. The Department is at present negotiating with the company regarding the year by year proportion of dead and green firewood. Over the life of the project, green and dead wood will be supplied in the same proportion as it occurs in the bush."

The EPA acknowledges that CALM has been entrusted with the responsibility for negotiating and managing the wood gathering contract in such a way as to maximise the forest management benefits.

5.5.3 Impact on other forest uses

5.5.3.1 Fauna habitats

SUBMISSION:

Concern over lack of knowledge of effects on fauna which use tree hollows.

The PER acknowledges on page 41 that "There is no information on the use of hollows by fauna in the jarrah forest and it is therefore difficult to assess the potential impact of large scale firewood extraction." The proponent is committed to funding post-graduate research, supervised by CALM, to provide more information on the subject. The EPA endorses this commitment. Several submissions expressed concern at this lack of information and recommended caution in various ways.

SUBMISSION:

The postgraduate research should be done before startup.

One suggested that the proposed postgraduate research should be completed before the project be allowd to go ahead, however the EPA considers this to be an overly restrictive approach given the relatively small proportion of the forest to be affected by the project in any one year, and the large quantity of wood of inferior quality which will still remain on the forest floor, according to CALM estimates.

SUBMISSION:

The use of hollows by fauna needs to be monitored.

The proposed postgraduate research to be sponsored by the proponent will involve monitoring of these effects to ensure the adequacy of the proposed management strategies.

In addition, CALM made these specific comments:

> "The Department funds a huge research effort to study fauna and flora in the forest. This is an ongoing program and includes detailed studies into the habitats of fauna. Assessments have indicated that there is at least double the volume of dead jarrah below the firewood specification which will remain in the bush. This material will provide more than adequate nesting areas."

5.5.3.2 Tourism

SUBMISSION:

What about the tourist potential of the forest?

The EPA considers that with the proposed limitations on logging operations the impact of the proposal on tourism will be minimal.

5.5.3.3 Salinity

This issue was raised in one submission. CALM's comment on the issue was:

> "The environment of the jarrah forest as a whole, is an area of widespread concern with respect to stream salinity. Concern over the possible adverse effects of bauxite mining led to the initiation in the mid 1970's of a large amount of research on land use and salinity in this area.
>
> There is now a very complete body of knowledge on regional trends in soil and stream salinity, and a great deal is known about hydrological processes in the region. Using this knowledge we are now able to predict with reasonable precision the consequences of any significant change in land use. The removal of dead standing trees or logs on the forest floor can have no possible influence on stream salinity. The removal of live trees could have an adverse effect only if all trees were removed, without regeneration, over large areas of forest in the eastern zone (less than 1100 mm rainfall). This could not happen, since the prime silvicultural objective of the removal of residue logs is to improve the quality of regeneration and to improve forest health and vigour. There are also forest management guidelines for the eastern zone of the forest agreed upon with the Western Australian Water Authority, which ensure that the amount of forest cover left after a logging operation does not fall to a level which would disturb the hydrological balance.
>
> Logging coupes are also widely dispersed over the forest. Normally only a small proportion of any catchment area is affected each year. "

Again, a management strategy which limits the proportion of the canopy removed will help to minimise any effects of the project on salinity.

5.5.3.4 Erosion

No submissions mentioned this issue, but CALM made the following observation:

> "Soil erosion control is covered in forest harvesting operations by prescriptions in operational manuals, when the logging contractor is obliged to install appropriate structures to contain erosion. Of more concern to CALM is the possibility of soil damage through continuation of logging operations in excessively wet conditions. This is approached in two ways ceasing harvest operations, particularly log skidding into the bush landings, and by requiring the contractor to carry out rehabilitation. The manuals also specify procedures to prevent entry of sediment into streams.
>
> Logging for the Silicon Project will be required to conform to all these specifications, consequently no additional erosion or stream sedimentation will result. "

5.5.4 Traffic

SUBMISSION:

What about noise from log trucks delivering wood?

Log trucks will be subject to the usual regulations with regard to vehicular noise, but undoubtedly there will be some additional noise. In addition to noise impacts, the EPA notes that log transport will impact upon safety, the use of roads by others and the level of maintenance required.

5.5.5 Other issues

SUBMISSION:

Why can't they use off-cuts from the jarrah mills?

Barrack offered the following comments:

> "Barrack Silicon Pty Ltd has considered the possibility of utilizing jarrah off-cuts as a potential feed for charcoal retorts. These studies are continuing, however there are several problems associated with off-cuts which at present mitigate against there use; namely:
>
> 1 There is a higher percentage of bark attendant with off-cuts than with whole jarrah tree trunks. The bark contains a higher content of undesirable nutrient minerals, and attached dirt than whole wood: thus adding contaminants to product silicon which impact adversely upon its marketability.
>
> 2 Jarrah off-cuts are sawn from freshly cut trees, and therefore contain excessive moisture which would need to be dried in stockpile prior to retorting. Although Barrack will dry 45% of log receipts from the CALM contract, it will receive approximately 55% dry (dry wood) which can be employed in the retorts immediately.

3 Charcoal retorts operate most efficiently when they are charged with uniformly sized feed. Off-cuts do not offer the size uniformity obtained from feed prepared in Barrack's own docking plant.

4 Even if the above can be overcome, or their effects minimised, there is an insufficient supply of mill off-cuts to support the silicon plant operation. The wood resource would still have to be supplemented by processing of some log timber.

While this reply indicates difficulties associated with using off-cuts it does not rule out that possibility. It may be that for some price incentive mills could provide off-cuts which are clean of bark and cut to Barrack's size specifications, reducing the need for on-site milling. As Barrack is to pay CALM $3.70 per tonne plus transport for unbarked, unmilled logs there should be some scope for further investigation of this option.

SUBMISSION:

CALM's priority is wood production. They shouldn't be responsible for environmental consequences of the project.

The EPA disagrees: CALM has many and diverse responsibilities in its management of the jarrah forest, and these are exemplified in the system of management priority areas it has developed with the aim of ensuring that each of these responsibilities is catered for. This breadth of view places CALM in an ideal position to effectively monitor the environmental effects of the project in the forest.

5.6 CHARCOAL PLANT OPERATIONS

5.6.1 Alternative sources of carbon

SUBMISSION:

What analysis was there of alternative reductants?

Several submissions raised the possibility of using some other source of carbon as the reductant for the furnace. Suggestions included Collie coal as well as coking coal from the Eastern States and paste from Norway.

The matter was also raised in a parliamentary question by the Hon WN Stretch on 3 December 1987. In response to that question, Barrack Silicon Pty Ltd prepared the following answer:

> "In terms of silicon production in the submerged arc electric furnace process, a reductant is any form of solid carbon which has suitable physical and chemical properties for the efficient and effective removal of oxygen to convert quartzite rock into silicon. The following chemical equation describes the process in its simplest form.
>
> Quartzite + Carbon -------> Silicon + Carbon monoxide
> SiO_2 + 2C = Si + 2CO
>
> The carbon source must have the right combination of reactivity, low electrical conductivity and be low in impurities so as not to contaminate the silicon product. Charcoal made from jarrah satisfied all these criteria well, in addition to being sufficiently dense and strong to withstand the mechanical stresses involved in transporting it and handling it in the furnace itself.
>
> The proponents have investigated a range of carbon reductants including local, interstate and overseas coals. Use of overseas and interstate coals would impose a significant economic and quality penalty on the Project. We have provided Western Collieries with considerable data and information to see if there is any possibility to use coal from this source to satisfy part of the Project's reductant requirements. At this stage this does not appear practicable due to Collie coal's high ash (8% on a dry basis compared to 0.2% for jarrah charcoal), and tendency to crumble into fines particularly on drying.
>
> Although the proponent will continue its investigations into the use of suitable alternative reductants to Jarrah charcoal, it should be pointed out that the availability of this charcoal is one of the few advantages which make the establishment of a silicon plant in Western Australia attractive, and without the availability of such a high quality reductant at an economic price it is unlikely that such a Project would proceed."

The EPA is also keen to ensure the proponent's commitment to charcoal as its primary reductant in view of the likelihood of other reductants generating sulphide emissions which would require some additional controls. In discussion with the proponent it emerged that the proponent plans to use a small quantity of petroleum coke at start-up.

The EPA asked the proponent for further information on the matter, and received in reply a letter which is reproduced in Appendix C. That letter explains that the quantity of petroleum coke proposed to be used will be small (about 10% of the total reductant charge) and that its use will be restricted to the initial start-up phase for added control of the furnace reaction. The letter explains that quality requirements demand an early switch to a charge of charcoal and woodchips. The proponent has also made a commitment to minimise and if practicable eliminate the use of "petcoke".

The EPA notes that any significant increase in the proportion of petcoke or any other non-charcoal reductant in the furnace charge would be subject to the provisions of Section 53 of the Environmental Protection Act 1986 which requires notification of significant changes of process. However, the EPA considers that for such changes of process additional assessment is warranted in view of the likelihood of undesirable emissions.

Recommendation 15

The EPA recommends that, should the proponent wish to alter its operations to use reductants other than jarrah charcoal and jarrah woodchips in a proportion greater than 15% of the total reductant charge, it should be required to present detailed management plans to the satisfaction of the EPA, outlining the likely changes in emissions and proposed control procedures.

5.6.2 Noise

On page 49 of the PER it states that "Noise control is discussed in Section 7.6". In fact there is no Section 7.6. Noise control is discussed in Section 7.4.4, but not in sufficient detail for adequate assessment. The EPA's recommendations with respect to noise attenuation are in Section 4.2.

SUBMISSION:

Sawing and feeding logs will create a lot of noise.
Concern that noise will be annoying.

The sawmill operation presents a potentially significant source of noise, particularly of a tonal nature due to the presence of numerous saws. Also the docking mill, splitter and drum debarker will be closer to those residents to the south and west of the plant site, and unscreened by other plant buildings.

The noise analysis in Appendix C of the PER assumes that all noise is generated at the plant centre, and takes only limited account of tonal component characteristics. That study recommends restricting the operation of the docking mill to the hours 0700 to 2200. While it does not specifically mention building attenuation for the sawmill and log splitter, the EPA considers that this will be necessary.

Figure 2 shows the detailed plant layout. Operations within the stockpile area will be less than a kilometre from residents southeast of the plant. While the wood stockpile will be closest to those residents the concerns apply to all stockpile operations. Mobile plant operations, especially reversing beepers and the grating of front end loader buckets on concrete, have proved to be sources of significant annoyance. These noises need to be attenuated.

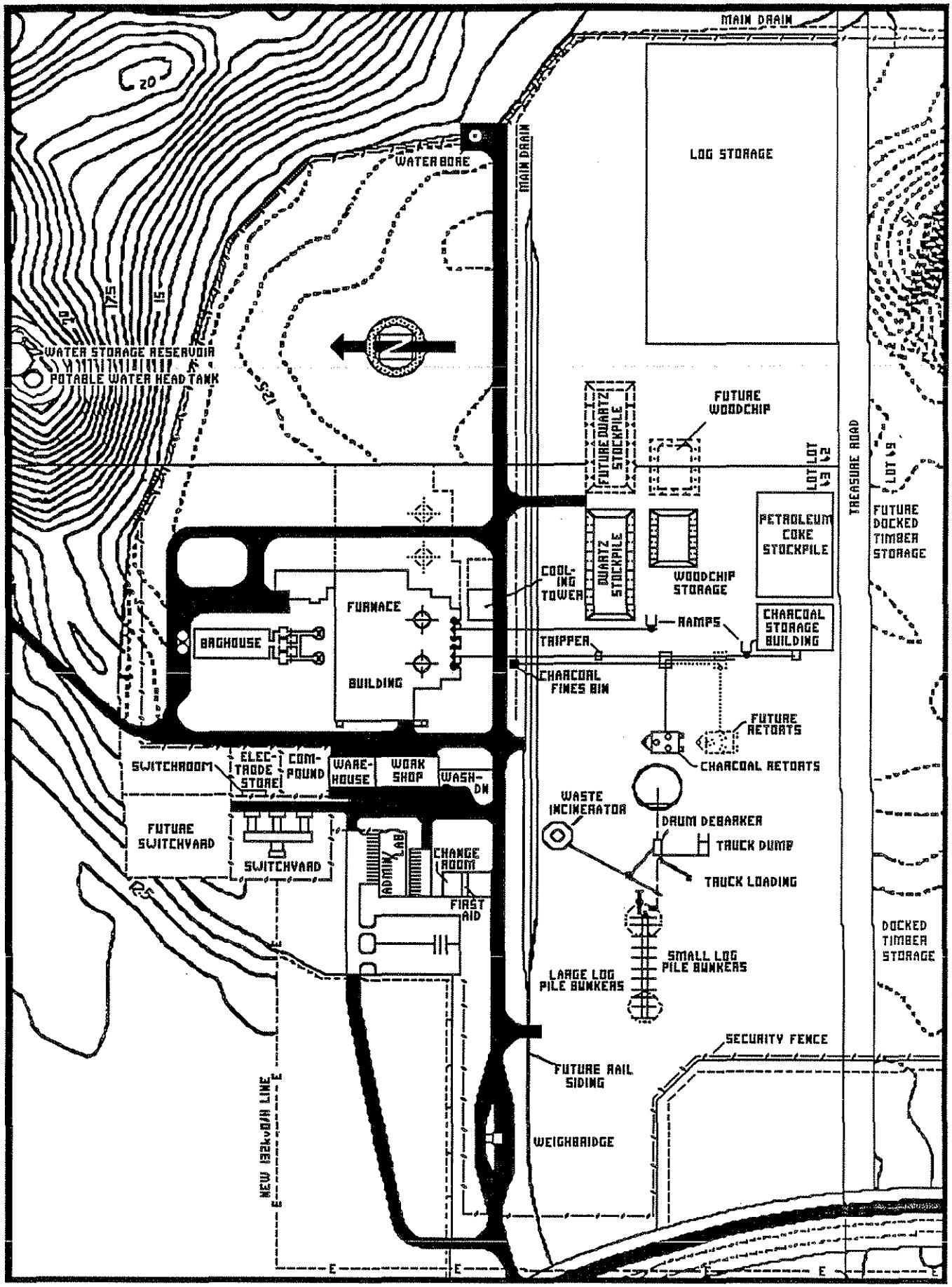

Figure 2 Barrack Silicon Smelter Site Plan for Picton Site

Another noise source of major concern to the EPA is the feed mechanism for the charcoal retorts. This mechanism is large and elevated so that effective attenuation at economic cost is difficult. Nevertheless, the elevation of this noise source ensures that the noise would be transmitted, to the annoyance of nearby residents, so attenuation is essential.

The nature of the feed mechanism has changed from the "bell" system described in the ERMP. The EPA asked the proponent for more details of the proposed feed mechanism and received the following reply:

> "Wood is batch fed to the retorts by a skip which is loaded by front end loader.
>
> The retort loading sequence is performed automatically with a manual override of skip movements by the loader driver.
>
> When the retort charge falls below a pre-set level the skip is activated by a level detector.
>
> The upper retort door, or swing gate opens automatically (initiated by a proximity switch) as the skip approaches.
>
> After the load is discharged through the upper door, the door closes, and a lower door (slide gate) opens to allow the wood to discharge into the retort.
>
> The lower door design incorporates an inert gas purge system whilst it remains open. After the slide gate closes, the feed system is ready for re-activation.
>
> The negative gas pressure maintained within the retorts, coupled with the inert gas purging system is incorporated to prevent possible emissions from the retorts."

Under the EPA's recommendations, the proponent is responsible for ensuring that the retorts are operated in a way which does not impose unacceptable noise or odours on surrounding residents. The proponents plans for noise attenuation of the rerort feed mechanism are of particular interest, and will be considered by the Authority as part of the works approval process under Recommendation 9.

5.6.3 Stormwater

SUBMISSION:

Why not recycle the water if it is clean enough to discharge?
Concern over discharge of water into Preston River.
What alternatives are there to river discharge of water?
Sedimentation ponds should be designed for a 100 year flood event.
What are the details of the drainage system?
What monitoring of water is proposed?
Oil and grease traps should be installed.

Many submissions raised issues associated with the discharge of water from the plant site. As the PER explains, the process is a dry process, and the only liquid effluent from the plant operation will be a small quantity of bleed water from the water cooling facilities associated mainly with the furnaces.

The main water disposal issues are associated with stormwater drainage. On this matter the Leschenault Inlet Management Authority raised a comprehensive list of issues which was referred to the proponent for comment. Barrack was not able to adequately address all the issues raised because design of those features had not been determined.

The EPA acknowledges the difficulty the proponent faces in giving details of issues which are yet to be decided, and considers that this matter can be best addressed at a later stage.

Recommendation 16
The EPA recommends that the proponent be required to prepare a detailed waste water management plan to the satisfaction of the EPA before the commissioning of the plant.

5.6.4 Handling of sawmill by-products

This issue was not raised in submissions, but is certainly of concern to the EPA. The sawmilling activities will generate splinters, sawdust, bark and trash which will be segregated and stockpiled for sale. The PER gives no details of the method of segregation, but it could obviously generate dust. In strong winds the stockpiles too could be a source of dust. They would also yield run-off water contaminated with tannin.

The EPA makes no specific recommendations with respect to these issues, but notes that the proponent will need to conform with the dust and waste water standards set by the EPA. Emissions from the by-products incinerator will also need to meet EPA standards and be operated so as to avoid annoyance to nearby residents as specified in Recommendation 10 in Section 4.

Submissions from Eaton residents claimed to be able to smell smoke from the Picton plywood plant on occasions. This suggests that it is highly desirable for the by-products to be sold if at all possible, and that the expected spare capacity of the incinerator and the ability to stockpile should be used to restrict incinerator use when weather conditions are unfavourable.

If the operation of the waste incinerator cannot be made environmentally acceptable by adjusting the timing of its operation, it may be necessary to transport wood waste off site for disposal.

5.6.5 Emissions from retorts and off-gas incinerator

The gases produced in the charcoal retorts contain a range of aromatic and toxic hydrocarbons. The PER claims that the incinerator through which these will be fed, and which also heats the retorts, has been so designed to ensure these toxic, aromatic gases are broken down to a harmless, odourless mixture of water vapour, nitrogen, carbon dioxide and oxygen. Two submissions questioned this:

SUBMISSION:

Concern over likely unpleasant odours.
What evidence that the incinerator will oxidise all organics and CO?

Barrack's reply was:

> "The incinerator has been specifically designed to burn retort emissions at high temperatures, and in the presence of oxygen drawn from outside of the furnace. Lurgi, the incinerator design engineers are world leaders in the design, construction and installation of retorts and associated incinerators. By contract, they are committed to provide Barrack Silicon with an incinerator that will meet all EPA emission standards. Lurgi gmbH have a demonstrated record of success in the design of such plants which stretches back over the last 30 years. Most of these plants relate to Lurgi's well known Spulgas process which involves the carbonisation of lower rank coals and the associated incineration of by-product gases."

Another submission questioned whether the nitogen and oxygen released might form toxic oxides of nitrogen after release. It asked whether there might be some danger to birdlife:

SUBMISSION:

Concern over downwind formation of oxides of nitrogen.

Barrack, in reply said:

> "The catalyst to produce oxides of nitrogen from what is normally a comparatively inert gas (nitrogen) is very high temperature. Our best advice is that at the temperatures and gas velocities involved the oxidation of nitrogen in the retort off gases will be minor and will have no measurable adverse effect on birdlife. In any event the retort designer Lurgi, the major company in the world in the design of carbonisation processes, is committed to ensuring that off gases from the retort comply with National Guidelines for control of emission of air pollutants into the environment."

The PER states (page 50) that "In the event of unplanned shutdown of the incinerator, the retort emissions will be vented directly to the atmosphere". Several submissions questioned this:

SUBMISSION:

Concern over direct venting of charcoal retorts.

In clarification Barrack offered the following:

> "It is not the intention to keep the retorts in operation in the event of incinerator failure. The period of any emission would be limited to the time taken to put the retorts in a shut-down condition. This is the reference on Page 50 of the PER which is poorly worded. The same comment as above applies. Lurgi is required by its contract with Barrack to deliver a retort facility which is in compliance with the National Guidelines for control of emissions into the environment."

While this clarifies the comment in the PER it is not fully satisfactory to the EPA which requires that there be no direct venting of the charcoal retorts in view of the offensive nature of the retort off-gases.

The PER gives the height of the charcoal retort incinerator stack, the highest feature of the plant, as 42 metres on page 50, while the air study by Steedman Ltd in PER Appendix B uses a height of 47 metres. Several submissions questioned this inconsistency:

SUBMISSION:

Two different heights for charcoal retorts.

Barrack, in reply said:

> "Relative to the observation of two heights reported by Barrack in the PER; the incineration stack height used by Steedman Ltd or the Wundowie ERMP and Picton PER air quality estimates/analyses was 47 metres. On p 28 of the PER, the stack height is listed at 42 metres. As engineering studies have progressed to the final design stage, the stack height has varied in accordance with the actual retort support structure. The height of the retort structure has been reduced somewhat by alterations to the bell loading system at the top of each retort. By lowering the height of the loading lock, the dimensions of the retort structure has been reduced. The stack height will exceed the height of the retort structure by 6 metres.
>
> The stack will be 45 metres tall in lieu of the original 47 metre estimate. Via personal communication with air pollution control authorities at the Environmental Protection Authority, the two metre difference between the Steedman Ltd studies and final design will not materially alter the conclusions drawn by Steedman Ltd: relative to stack emissions."

SUBMISSION:

Do data on top of PER p 28 relate to jarrah or some other wood?

Barrack:

> "The charcoal retort emission gas chemistry listed on page 28 of the PER relates to jarrah wood carbonised in the vertial retorts at Wundowie. The carbonisation sections of the Wundowie retorts are fundamentally identical to those proposed by Barrack Silicon Pty Ltd."

5.6.6 Charcoal handling and dust control

The EPA is concerned that the generation of charcoal dust is adequately controlled. In this regard it sought clarification from the proponent of its plans for storing charcoal fines. The PER states that fines destined for sale will be stored in covered bins, but does not specify the storage method for fines intended for incineration. In repy to the EPA's query, the proponent gave the following:

> "The charcoal is screened before being conveyed to the silicon furnaces or to a short term product stockpile. The short term product stockpile is in a partially enclosed building. Undersized charcoal (less than 5 mm) will be stored in an 80 cubic metre bin prior to loading into trucks for transport and sale as a by-product of the charcoaling operation."

The EPA is aware of the possibility of dust being generated from several product handling and storage areas and unsealed access roads and makes the following general recommendation with regard to dust.

> **Recommendation 17**
> The EPA recommends that during operation of the plant the proponent be required to stabilise stockpiles and unsealed access roads on the plant site and take other appropriate measures to ensure that dust levels at the plant boundary do not exceed the level specified by the EPA. This level and the associated management measures required by the EPA will be set as part of the works approval process.

Many nearby residents rely on rainwater collected from roofs as their sole source of domestic water. Some expressed concern at dust contaminating that supply:

SUBMISSION:

Concern over effect of charcoal dust on quality of rainwater collected from roof.

The EPA believes that if the dust levels referred to in the above recommendation are adhered to, there will be no noticeable effect on rainwater collected beyond the plant boundary.

5.7 SILICON SMELTER OPERATIONS

5.7.1 Health implications of silica fume

SUBMISSION:

Concern that medical authorities differ over toxicity of fume (including references to Wnekowski report).

One of the major issues raised in submissions and discussed both at the public meeting and in the press was the possibility that amorphous silica fume may be fibrogenic when inhaled by humans. It is understandable but unfotunate that the discussion was not always factually based. To some extent, the wrong question was being asked, and the wrong answer given.

Many people were seeking a guarantee that the substance was completely harmless. This cannot be given because in laboratory experiments where high concentrations have been forcibly inhaled by rats it has produced fibrous tissue in their lungs. There is less certain evidence that in some workers exposed over many years to high concentrations of fume, fibrous tissue may have been produced. However both these cases are essentially irrelevant to those raising the issue in submissions. What they need to know is that at the concentrations which they as nearby residents are likely to encounter every day the dust poses no risk to their health.

The PER questions the applicability of some research on the basis that the fume may have contained some crystalline silica. In its supplementary fume study (Appendix B of this Report) it claims without corroborative evidence that "contamination with crystalline silica is apparently exceptional rather than inevitable, and may be a function of the nature of the quartz charged to the furnace." From this it can be concluded that the Company cannot be unequivocal that there will not be a small percentage of crystalline silica or of cristobalite in the fume of its silicon furnaces. The real issue is the health risk of the dust given off by the furnaces, whether or not it is 100% amorphous.

The EPA referred this issue of the health implications of silica fume to the Health Department and the Department of Occupational Health, Safety and Welfare (DOSHWA). Both were provided with copies of the report by Dr Wnekowski and the evidence of other medical experts presented to the appeal hearing in connection with the Electrona smelter. The Departmental responses are reproduced in Appendix E.

DOSHWA acknowledges the contention over the issue in the literature, and suggests that it may apply some caution with respect to setting occupational health standards for the Picton smelter.

The reply from the Health Department specifically addresses the public health issues which were of greatest concern to the many who raised the issue in submissions. The reply indicates some inadequacies in the treatment of the subject in the PER. It refers to the "well researched paper" of Dr Wnekowski and its "valid observations" which raise issues requiring a further review. It points to the Barrack silica fume study (Appendix B) as providing that review, and describes it as "excellent". The reply goes on to state:

> "As stated in all the papers submitted and additional review of the literature available to this Department, there are no public health standards for silica fumes. Consideration should therefore be given to the nature of the fume and the risk to public health from the emissions of such fumes. It is well accepted

that amorphous silica by itself does not seem to give rise to public health concerns but under certain circumstances, in particular high temperature incineration, it can transform to cristobalite and then a potential silicosis hazard may occur.

The risk of this happening given the kind of emissions described in the PER has been well assessed in the Maunsell and Partners Report when operations both under standard and non-standard situations have been described. The assessment under a "worst possible case" condition appears satisfactory.

In this regard and with this background, it is appropriate to use the draft occupational health standards for silica fume of 2 mg/m^3 to attempt to derive public health standards. An annual average of 0.07 mg/m^3 and a 24 hour average of 0.10 mg/m^3 seem quite appropriate and do not seem substantially different to the WHO guidelines at present proposed for total suspended particles.

If the plant is capable of operating within these standards, it is unlikely that there will be any public health concerns."

SUBMISSIONS:

The TLV in the PER is for silica precipitate or gel, not amorphous silica. It is a total dust limit, not a respirable dust limit.

Dr Gross recommends a TLV of 50ug/m^3 (100 times as stringent as the limit for nuisance dust).

Report "I can't guarantee people's health..." Spratt

Dust may be found harmful in 20 years' time.

These issues are clearly related to public health which has been appropriately addressed above by the Health Department.

SUBMISSION:

Concern that children are more at risk.

This point was raised in Dr Wnekowski's paper, and several submissions referred to it. While its validity has not been questioned, the above reply from the Health Department was given in the light of it, and the conclusion about the absence of public health concerns applies to children in neighbouring residential areas.

SUBMISSION:

Concern that fume will make worse health conditions such as: Asthma, Cystic fibrosis, Emphysema, Allergies, Hay fever, Bronchitis and other problems of chest, nose and throat.

The Health Department reply states:

"it is believed that the levels recommended will protect all but the most sensitive of individuals."

Barrack also offered comments on this and the previous submission:

"Barrack Silicon is proposing to the EPA that stringent standards be applied to this project to ensure the protection of public health.

The standards are considerably lower than those applied for occupational health purposes and are specifically designed to take account of the fact that people with breathing problems and children may be exposed.

Barrack Silicon is confident that its operations will be well within these standards and that there is therefore very little potential for adverse health impacts."

The EPA has recommended stricter standards than Barrack proposed by requiring no direct venting of the furnaces. In view of the advice from the Health Department, the proponent's assessment of the health risk would appear to be accurate.

SUBMISSION:

Control of dust from cartage and stockpiling of raw materials.

This issue has already been adequately addressed in Section 5.6.6.

SUBMISSION:

Concern over effect of fume on quality of rainwater collected from roof or of swimming pool water.

In reply to this concern, the Health Department has said:

"There is no indication that the ingestion of silica dust poses any public health risk."

Also Barrack offered the following observations:

"The potential health effects associated with fume emissions relate to breathing of airborne dust and resultant lung damage. There are no adverse health implications from ingestion (swallowing) of fume.

Swimming pool filters contain a type of amorphous silica known as diatomaceous earth."

SUBMISSION:

The PER has no information on particle size.
Won't particle size be so small it is all respirable?
Will the baghouse capture very fine (<1um) particles?

These issuse are closely related. Barrack's reply to the second covers the concerns of the other two:

"The particle size of fume ranges from 0.01 to 1.00 microns which in clinical terms would class it as a respirable dust. However the fact that fume is a respirable dust does not necessarily imply that it is a public health risk; and it is only one of many forms of dust in our atmosphere which are respirable.

Nevertheless, Barrack Silicon Pty Ltd has gone to great lengths, technically, operationally and capital cost-wise to incorporate state of the art silicon production facilities which will minimise the escape of fume from the plant site; and which will insure the communities surrounding the Picton plant are not exposed to plant emissions beyond recognized safe limits."

SUBMISSION:

Will silicon metal in the fume affect it's reactivity?

Barrack's reply to this question was:

"In all the literature searches conducted by B arrack and its environmental consultants relative to the effect of fume on both man and experimental animals, no evidence has been found to suggest that silicon metal dust ever reports in the fume.

Silicon is a very stable material. With respect to the question of a silicon content in the fume and increased reactivity: silicon does not report in the fume and thus is not a consideration in matters relating to fume."

SUBMISSION:

All workers shoud be informed of the health risk.

This issue is one of occupational health, not environmental assessment.

SUBMISSION:

What is the impact of the dust on chickens?

It seems likely that if there is no unacceptable risk to public health, chickens will also be safe.

5.7.2 Emissions of silica fume and operation of the baghouse

SUBMISSION:

Doubt that dust emissions will be as low as claimed.
Relying on achievement of manufacturer's claims 100%.

There are two ways of reducing or removing the doubts expressed in these submissions. One is to ensure that the dust control equipment to be installed is adequate to the task from the EPA's viewpoint. The other is to impose penalties if the required standards are not met.

The nature of the proposed baghouse is such that the level of emissions from the plant varies with different phases of baghouse operation. When the baghouse is operating the maximum fume content of air emitted from the baghouse slots is claimed by manufacturers to be 50 mg/m^3. However, this maximum rate only applies while the filter cake has not developed in the bags. Once the cake has developed, capture efficiency is greatly increased and on average, allowing for the closure of one module for reverse pulse cleaning or bag maintenance, an emission level of 4 - 5 mg/m^3 is expected.

With the proposed baghouse design, according to the PER, there will be times when the Company will wish to shut off the baghouse and allow the fume given off by the furnaces to be released directly into the atmosphere. These occasions relate to both scheduled maintenance and unexpected breakdowns. The justification for direct venting in each of these instances was not well addressed in the PER, but communications from the Company in response to questions raised by the EPA indicate that the primary reason is to protect the baghouse from sudden increases in gas temperature when the furnace is operating in an unsteady state.

In fact the furnace gases in the steady state are also too hot for the baghouse fibreglass bags, and it is necessary under normal baghouse operation to dilute them with outside air in the ratio 80:1 to cool the gases sufficiently. The claimed direct venting events are mostly events where the temperature of the furnace gases increases to a level which the present baghouse design cannot handle, either because the fans or the bags cannot handle the larger volume of dilution air required to drop the temperature. One solution is to direct vent; another is to build a bigger baghouse.

The issue of direct venting of the furnaces caused a great deal of concern.

SUBMISSION:

Won't only one baghouse mean more direct venting?

Several submissions noted the change from two baghouses in the ERMP to only one in the PER. Barrack's reply was:

> "The baghouse concept has changed between the preparation of the ERMP in 1986 and the writing of the Picton PER in late 1987; principally as the result of the application of test data related to the efficiency of the West Australian raw materials to the baghouse design.
>
> The generation of silica fume has been predicted to be much reduced due to Barrack and Demag review of plant trial data. For this reason, the industry standards applied to the Wundowie ERMP have been discarded in favour of the more representative estimates derived from actual plant operation using Barrack's intended raw materials.
>
> The scheduled and unscheduled direct venting estimates listed on pp 60, 61 of the PER relate to the single baghouse concept. The overall filtration area for cleaning of furnace off-gases is not reduced by the single baghouse concept. The comparison is merely one between two discrete buildings (or houses) and a single equally efficient and effective building without any dividing wall included."

An issue which became significant in the light of international comparisons was that of just how much direct venting was necessary.

SUBMISSION:

Electrona had 200 hours direct venting during commissioning, and another 200 hours since then.

Evidence from the Tasmanian Department of the Environment indicated that the submission with regard to the amount of direct venting at Electrona was not correct. The 200 hour limit was not applied to the commissioning period, and since commissioning up until late January, 1988, the 200 hour limit had certainly not been exceeded.

SUBMISSION:

Why not have backup generators for the baghouse?

The EPA sought clarification on the design of the baghouse and the implications of the failure of a baghouse fan. Barrack's reply was:

> "There will be two main fans rated at 20% above expected peak duty.
>
> The baghouse will continue to operate with one disabled fan, however with both furnaces operating at full load (18MW) under steady state conditions, furnace power would have to be reduced by 15 to 20%.
>
> Under the above circumstances, short term conditions would result in increased temperatures from the furnace off-gas and the possibility of astmospheric venting to protect the baghouse from the increased temperature. At the reduced power level, and steady state furnace conditions direct venting would not be required.
>
> In the event that the two furnaces were operating at full load (18MW), but in an unsteady state, the furnace power would need to be reduced to a minimum of 20%, and direct venting would be necessary until the reduced power and steady state conditions were regained."

SUBMISSION:

The Oregon plant does not direct vent, why should this one?
To say direct venting will be "timed to avoid.." is too vague.

The EPA considers that since the Oregon plant has successfully operated under conditions requiring no direct venting then such conditions should appropriately be applied to the present "state of the art" proposal.

Several submissions raised concerns relating to the possible organic content of the furnace off-gases.

SUBMISSION:

Discussion of organic emissions from furnace is inconclusive.
Will the use of green jarrah chips generate organic emissions?

In reply Barrack provided the following:

> "Barrack Silicon has found it feasible to operate the project baghouse at Picton at reduced temperature (of the order of 80^{o}C) based upon operating plant tests employing West Australian charcoal and quartzite.

With respect to the use of woodchips as furnace stabilizing agent reductant, the actual annual tonnage estimated for consumption is presently of the order of 18,250 tonnes in lieu of the PER estimate of 24,000 tonnes. Improved furnace efficiencies are again cited as the reason for the reduced requirement.

Nevertheless the submission to the EPA is correct in that the introduction of green Jarrah blocks into the furnace also will produce minor quantities of steam and organic products of wood incineration.

The available data on organic emissions from silicon furnaces is very limited and indicates very low emission levels. The presence of organics is probably attributable to the stabiliser and reductant used in the furnace and will vary accordingly from plant to plant depending on what material is used for these purposes. At Picton, organics could theoretically derive from the wood blocks added to the furnace as stabiliser. However, the high temperature of the furnace can be expected to effectively destroy any such substances.

The matter can only be resolved by specific analyses of the emissions as proposed in the PER."

The submission from the Mines Department also addressed this issue:

"Organic emissions from the process plant should be free of aromatic hydrocarbons due to the single species of hardwood to be used for charcoal production (Section 4.3.1 of the PER) and the higher temperatures used in the furnace."

On the basis of this advice of this advice the EPA considers that there is little likelihood that organic emissions from the furnace will be detectable beyond the plant boundary. However, the proponent's commitment to monitor furnace off gases is noted and endorsed.

SUBMISSION:

The lower melt temperature may lead to impregnation of bags with pyroligneous vapors, reducing efficiency.

This submission was not referred to Barrack in view of the indication in the above reply that such substances would likely be destroyed in the furnace.

SUBMISSION:

What evidence is there that the known carcinogens produced by the Alabama plant won't exceed acceptable levels at Picton?

Barrack offered the following reply:

"It is an established fact that closed furnaces generate higher levels of organic emissions than open furnaces. The furnace at the Alabama plant is a closed type which results in incomplete combustion of organics released from the high volatile coal which is the major reductant in use at this facility. This high volatile coal (containing up to 50% volatile matter by weight) along with petcoke and woodchips constitutes the reductant mix for the Alabama furnaces. In contrast the Barrack plant has furnaces which are of open design promoting the more complete burning of organics.

In Barrack's case furnaces will operate with charcoal as the principle reductant. The jarrah based charcoal has a typical volatile content of 6% or less when it enters the silicon furnace, the volatiles having previously been removed and fully combusted in the incinerator of the charcoal retorts."

SUBMISSION:

What percentage of carbon monoxide (CO) from the furnace is oxidised with/without the baghouse?

Barrack replied:

"Basically 100% of the CO will be oxidised to CO_2 at the furnace prior to being drawn into the baghouse. This is because the Barrack furnaces are of open design allowing the mixing of CO by-product with atmospheric oxygen above the furnace and the bottom of the furnace hood. This results in furnace gases including CO being diluted in the ratio 80:1 approximately, allowing ample excess oxygen for complete oxidation of CO to CO_2 prior to entering the furnace exhaust duct leading to the baghouse."

SUBMISSION:

What quantity of CO_2 will the furnaces and retorts generate?
What will be the effect on the ozone layer?

Barrack's reply:

"The electric furnaces will generate approximately 100 tonnes of CO_2 per day, and the charcoal retorts 37 tonnes daily.

As a matter of comparison, the State Government operated power plant at Muja would generate CO_2 from the combustion of Collie coal at a level which is at least two orders of magnitude higher than that anticipated for the Barrack Silicon Project. Similarly the nearby Bunbury power station would generate at least a 10 to 15 times greater volume of CO_2 than the Barrack Silicon plant on an annual basis. Re-stated, by international standards, the Barrack furnaces are of very low order compared to other industries with respect to CO_2 generation.

Recent research tends to implicate chloroflourocarbons as the principal cause of ozone layer depletion. The Alliance for Responsible Chloroflourocarbons Usage in the USA has recently called for a ban on the use of all aerosols containing CFC. The continued use of Freon or similar refrigerants is also cited as having an adverse impact upon the ozone layer.

By comparison the level of CO_2 generated by the proposed Barrack Silicon Plant will have a negligible effect compared with other known natural and man-made influences on the stratosphere."

The EPA notes that the principal concern with regard to CO_2 production is not its effect on the ozone layer but rather its blanketing effect, reducing the amount of infrared or heat radiation which escapes from the earth's surface to space. The CO_2 produced by this plant will undoubtedly add to that effect, but its effect will be extremely small in the global context, and certainly could not provide grounds for rejecting the project.

SUBMISSION:

What about the ozone produced by electric arcs?

Barrack's reply:

> "The reduction furnace requires energy to heat the furnace feed to reduction temperature. The energy is obtained by drawing an arc through the mixed quartz and charcoal charge (resistance). The voltage is of the order of 190 V nominal between phases and 190 V between the electrodes and the surrounding molten bath.
>
> In order to ionise air, high voltage arcs are required; and because the proposed furnaces do not produce high voltage arcs, any air that might be present in the bath would not be ionised.
>
> Additionally, ozone is a very unstable gas, and could not persist in the reducing atmosphere of the submerged arc electric furnace; which by design removes oxygen from the mineral quartz, and produces Si and $C0_2$ as reaction products.
>
> The electric arc furnaces will not produce ozone, and thus, ozone will not affect the area surrounding the plant, or its atmosphere."

SUBMISSION:

Change to another reductant - site would be less suitable.

This issue is adequately addressed in Section 5.6.1

5.7.3 Transport and handling of fume

The PER indicates that the local demand for silica fume is likely to be in excess of supply, and that likely customers would collect and transport the fume in sealed road tankers. While the EPA finds this method of handling fume satisfactory, it is quite likely that there will be occasions when sales are temporarily interrupted. Also it is possible that on occasions the amorphous silica fume will be contaminated with crystalline silica to an extent which makes it unacceptable to the cement trade. For both these reasons contingency plans are necessary.

SUBMISSION:

What are the plans for fume disposal if it cannot be sold?

In reply Barrack said:

> "A pelletising or humidifying system will be included in the baghouse facility in order to allow fume to be stocked if sales are temporarily interrupted."

A pelletising or humidifying system will stabilise fume sufficiently to enable limited short-term storage on-site, but the limits need to be defined, and a suitable site for dumping and burial located. With regard to on-site storage, the discussion and recommendation in Section 5.6.6 are relevant.

Recommendation 18
The EPA recommends that the Company be required to prepare and implement a plan for the management and disposal of silica fume to the satisfaction of the EPA before commissioning of the plant.

5.7.4 Noise

The issue most frequently raised in submissions was that of noise. As has been established in Section 5.1.6, the surrounding residential areas are quiet and their occupants are likely to be sensitive to any increase in noise levels. General noise-related issues are discussed elsewhere, only those specific to the silicon smelter operation are discussed here.

SUBMISSION:

There have been on-going noise problems at Electrona.
Bigger than Electrona, so more noise is likely.

The EPA believes that the problems experienced at Electrona can be avoided at Picton if the recommended noise levels are adhered to. The Authority believes this is possible, but that it will probably require extensive noise attenuation.

SUBMISSION:

The shot gun should be used during the day time only.

In referring this issue to the Company, the EPA pointed out that the Electrona plant does not use the shotgun between 2200 and 0700 hours. Barrack's response was:

> "Barrack Silicon's proposed operation varies considerably from that at Electrona, if only by the fact that Barrack will be operating two furnaces which essentially double the required tapping frequency of the Tasmanian project. Furthermore the Barrack Silicon Project is specifically targetting the high quality end of the silicon market which demands a silicon product low in iron (Fe content of 0.2% or less). Therefore the routine use of taphole drills, iron bars or excessive oxygen lancing to open the furnace taphole is not permissible as it will result in iron contamination of the product which is impossible to remove in the subsequent refining stage.
>
> The taphole gun which uses a simple zinc slug is the most efficient and effective means of quickly opening the taphole of a silicon furnace and is used by all high quality silicon producers including Elkem Metals, SKW, Dow Corning, Liasa and Samancor. Barrack Silicon would suffer both loss of revenue and competitive position if precluded from using the taphole gun on an as-required basis at any time (i.e. day or night).
>
> Barrack, in consideration of the adjacent communities, would endeavour to avoid the utilization of a shotgun for furnace tapping purposes whenever practicable, but cannot make a commitment to absolute avoidance during the night.

> Barrack is of the opinion that the audio impact of a shotgun detonation directed to a tap hole in an enclosed building 1.5 kilometres from the nearest residence will not have the sound pressure level outcome at residential locations which is currently being assigned to it. "

The issue was also addressed by DOSHWA in its initial response, where it expressed some concern from the occupational health viewpoint:

> "The use of the shotgun tapping process is considered to be capable of generating peak noise levels higher than 140dB (LIN) which can cause instantaneous damage to hearing. An alternative to this operation should receive special attention."

This suggests that occupational health considerations will dictate special attenuation measures if the use of the shotgun is to be allowed. These may adequately address the wider noise generation problems associated with shotgun use. However, while hearing protection devices can also be used to reduce occupational noise problems they have no effect on the noise generated. The shotgun is among the items listed as requiring special attention under the EPA's recommendations with respect to noise in Section 4.2.

5.7.5 Water supply and use

The use of water at Picton will be mainly for cooling purposes, both in the charcoal retorts and the furnaces, with lesser quantities for dust suppression, fire control and the domestic needs of the workforce. The estimate of the daily requirement has been changing as more information has become available. The 1986 ERMP estimated 335m^3/day, the November 1987 PER quoted 220m^3/day on page 22 (presumably just referring to the silicon production process), and 350m^3/day on page 46 as a peak total plant water requirement. The Company's reply of 8 February 1988 to the Leschenault Inlet Management Authority's submission gives the most recent estimate as 650 - 750m^3/day.

SUBMISSION:

Was WAWA water licence issued a fortnight after Bunbury Water Board recommended a moratorium?

One submission saw the issue of the licence as inappropriate in another sense, in that the Bunbury Water Board (BWB) had been warning Bunbury residents of a shortage of water in the Yarragadee aquifer from which it draws its supplies and had written to the Minister for Water Resources recommending a moratorium on further licences in the Leederville aquifer and requesting access to that aquifer. It claimed that WAWA had issued the licence to Barrack just a fortnight after this moratorium had been requested.

Advice from WAWA indicates that this is correct, but the matter is complicated since the power to issue licences is delegated to the regional office which was not informed by BWB of its request to the Minister. In the event no moratorium was imposed.

SUBMISSION:

Concern over the quantity of water and threat to supplies.

The quantity of water covered by the WAWA licence was 365,000m^3 per annum (1,000m^3/day). By issuing the licence WAWA clearly indicated its belief that that quantity could be drawn from the aquifer without threatening supplies.

In support of this view, the Department of Mines in its comments on the PER said:

> "Groundwater requirements at both site are low, with both the ground water quality and quantity suitable.
>
> The process should not adversely affect the groundwater quality in the aquifer."

Further, at the public meeting a WAWA Officer, after pointing out that the licence amount was equivalent to that needed by 30 hectares of irrigated pasture, went on to say:

> "It is a significant amount of water but there is adequate water within the aquifer underneath the site to go on supplying that quantity of water without threatening any supplies or any other existing users of water."

On the basis of these assurances the EPA accepts that the water supply proposals will not have any adverse environmental effects.

SUBMISSION:

The water source should be monitored for quantity and salinity.

In view of the above assurances, while it is highly likely that the Company will need to monitor water quality and quantity for its own purposes, the EPA does not consider a requirement to do such monitoring necessary at this stage.

5.7.6 Other considerations

SUBMISSION:

What extra noise/dust will result from the expansion to 29,000 tonnes?

It was reported in the 'West Australian' on 15 December 1987 that the proposed plant would be producing 29,000 tonnes of silicon per annum by mid-1989. Several submissions asked whether this expansion would lead to increased emissions of noise or dust. The Company's reply was:

> "The potential to increase the plant's production level from 24,300 tonnes to 29,000 tonnes of silicon per annum progressively within five to six years of start up is the result of increased process efficiency.
>
> In basic terms, at a production level of 24,000 tpa of silicon, a silicon recovery from quartz of about 86% is achieved; the balance of the silicon in quartz ending up as SiO_2 by-product fume. At a production level of 29,000 tpa of silicon, a silicon recovery from quartz of 94% is achieved: resulting in a much lower generation of by-product fume.

The calculated annual fume generation would drop from 8,000 tpa to 3,970 tpa (at 94% recovery). Because the increased silicon output is purely associated with increased control of raw materials and improved process efficiency, there would be no perceptible change in noise levels as silicon production is increased."

SUBMISSION:

Why not use Bunbury port?

This issue is adequately addressed on page 46 of the PER where the Company says that it will use Bunbury port "should appropriate container facilities and shipping carriers become economically available".

SUBMISSION:

Eaton has frequent electrical interruptions.

The plant will be supplied with a dedicated dual 132kV power supply; it claimed the security of the power supply was a distinct advantage of this site over others it had considered.

SUBMISSION:

How much power is needed? What sort of lines will be used?

These questions were asked at the public meeting. In reply the Project Manager said:

"The two furnaces are nominal 18 - 20 megawatts, total power consumption is in the order of 45 megawatts total.

....power lines are very much the responsibility of the State Energy Commission. As you know there is already a 132 kV feed into the Picton sub-station from Muja. The intention is, and was in any event, as part of SEC's thrust to improve the power security to the south west, to install a double circuit line, that is a second 132 kV line."

The EPA notes that the area is already criss-crossed by many power lines, and does not consider the additional lines required for the project will have a significant environmental impact.

SUBMISSION:

Is the price paid for electricity subsidised?

This question is not directly related to the environmental assessment of the project. It was asked at the public meeting, and was answered by the Project Manager in the negative. He said that the price paid was the subject of a confidentiality agreement and declined to reveal it.

The questioner expressed dissatisfaction at this, and asked how it was possible to make a judgement on the possible benefits of such projects to the State when these prices were not known. The EPA considers that such information is peripheral to the present environmental assessment.

SUBMISSION:

What will be the electromagnetic effects on radio, TV, industry?

Barrack's response to this issue was:

> "With respect to electrical interference produced by the electric arc furnaces: arcing of the furnace may manifest itself in harmonic currents which are presented in the power supply. Harmonic filtering will be incorporated in the system to meet SECWA standards."

It is the EPA's understanding, confirmed by SECWA, that any TV or radio interferecne effects from the power lines or the furnaces would only affect their immediate vicinity for less than 100 metres. With regard to health effects, the consultants' report to the EPA on the subject (Scott and Furphy, 1987) indicates no health effects from 132kV transmission lines. Electromagnetic radiation from the furnace operation is very localised. The voltage used is only 190V. The effects are almost solely magnetic; they are of no public health significance and according to DOSHWA unlikely to be of occupational health significance.

SUBMISSION:

Is separation between furnace and watertable adequate? (it was a problem for the Aluminium smelter at Kemerton)

Barrack's reply was:

> "The apparent problem at Kemerton centred about the proximity of electrical apparatus and (or) possible heat loss to the ground/water table.
>
> The Barrack furnaces stand above the plant floor (tapping floor RL 16.2m) and the major electrical sources are located at RL 20.3m.
>
> Summer and Winter water table levels are RL 11.0m and 12.5m respectively.
>
> As the reaction within the furnace is wholly dependent upon heat, the furnace shells are lined with the highest quality refractory brick to prevent heat loss, either from the exposed sidewalls or bottom of the furnace shell."

SUBMISSION:

Why is Electrona stockpiling silicon?

This is not an environmental issue. The EPA would expect Barrack to develop a stockpile of product to enable it to guarantee its ability to meet orders. Environmental management of the stockpile is covered in Section 5.6.6.

5.8 GENERAL IMPACTS

5.8.1 Site layout

The site layout provided in the PER was preliminary and lacked some important information such as an indication of north. Some submissions noted this.

SUBMISSION:

Neither site layout indicates north.
What parts of the plant are closer than the centrepoint?

For its own research purposes the EPA requested more detail from the proponent, and maps were provided which enabled the Authority to draw up Figure 2. This shows the location of all the major features of the plant. It also indicates some of the proponent's preliminary thinking with regard to expansion of the plant, which are discussed below in Section 5.8.4.

5.8.2 Visual impact of the plant

SUBMISSION:

A landscape and screening plan should be a condition.
What sort of trees will there be in the buffer?

The development of a landscape and screening plan is a specific commitment by the proponent, so it is not necessary for the EPA to apply a parallel condition. However, the plan needs to be satisfactory to the EPA. Nightime illumination of the plant is also of significant visual impact and needs to be approved by the EPA.

Recommendation 19

The EPA recommends that the proponent be required to prepare and implement a plan for nightime illumination of the plant and that this plan and the landscape and screening plan to which the proponent is committed be required to be approved by the EPA before commissioning.

5.8.3 Height considerations relative to Bunbury Airport

The Federal Department of Aviation places stringent restrictions on the height of constructions near to airports for safety reasons. Off each end of the runway there is an approach/take-off path within which a height/distance ratio of 1.6 applies, out to a distance of 3 kilometres. (For example, a building 16 metres higher than the aerodrome could be no closer than 1000 metres.)

In addition, out to a radius of 4 kilometres from the runway there is a general height restriction of 45 metres above the level of the aerodrome. Beyond that distance, the permitted height increases at 5 per cent.

Bunbury Airport, according to the Department of Aviation, has an altitude of 53 feet, or 16 metres. This compares with contours of 12 and 14 metres at the proposed plant location. That location is approximately 5 kilometres from the eastern end of the runway. At that distance the height restriction is:

(45 metres + 5% of 1000 metres) = 95 metres

The highest element in the plant is the stack from the charcoal gas incinerator. On page 50 of the PER it is described as 42 metres high, while Appendix B quotes a height of 47 metres. Both heights are well within the restriction.

5.8.4 Impact of expansion and downstream industries

Some submissions, aware through the press of the proponent's hopes for expansion, queried why it was not covered in the PER.

SUBMISSION:

Press reports mention future doubling of plant but PER doesn't.

The EPA understands that the proponent has no firm plans for expansion, and notes that any significant expansion of the plant would require separate environmental assessment, and be subject to considerations of cumulative environmental impact.

SUBMISSION:

Will downstream industries bring more dust and noise?
Will it be too dusty for "high tech" industry nearby?

Barrack's reply to the possible negative effects of potential downstream industries was:

> "Barrack Silicon Pty Ltd does not necessarily agree to the inevitability of downstream industries being located in the Picton site vicinity. However, the areas around the site are zoned for industrial development and provided economic criteria are satisfied, downstream industries could be attracted to the area.
>
> However, in the event that related industry developers become interested it must be assumed that such potential developers will be required to comply with EPA conditions just as has been the case with Barrack Silicon Pty Ltd. The assertion that the existing proposal will cause pollution control problems is unwarranted, as is the assertion that future industry will cause further problems.
>
> The term Metallurgical Complexes is so general as to beg further definition and the impacts of such complexes when defined would undoubtedly range over a very wide spectrum. In the event that an aluminium smelter is ever established at Kemerton, some of the silicon produced at Picton could be directed to Kemerton for alloying with primary aluminium.
>
> Alternate downstream industries which might be attracted to the Picton/Bunbury district entail quiet, dust free, chemical/high technology processes which most communities concerned with their future economic well being would consider to be highly desirable."

And from another response from Barrack:

> "The matter of increased community dust levels caused by the Barrack project resulting in the exclusion of potential "high tech" industries from the general area is arguable from two points.
>
> 1 Barrack contends that its presence will not markedly alter the existing dust levels in the Picton Junction area and
>
> 2 Many of the so called "high tech" industries are conducted interior to their own created micro environment free of all forms of dust."

The EPA will apply dust standards at the plant boundary as part of the works approval process which should ensure conditions acceptable for most industries within the industrial area. The EPA considers the plant is much more likely to limit the establishment of other industries by its use of the available capacity for noise generation from the area.

5.8.5 Contingency and emergency plans

One submission expressed concern over the danger to nearby residents from accidents at the plant.

SUBMISSION:

What danger is there from accidents?

Barrack's reply was:

> "Both silicon and charcoal production are dry processes employing heat as the energy source. There are no associated large tanks of either liquid or gas involved which would present a risk of a major chemical or gaseous disaster in the surrounding areas.
>
> Industrial accidents which might be possible around a silicon furnace could be associated with an electrical fire, or the escape of molten silicon via a burn through of a furnace wall. In both cases, the surrounding communities would not be affected - or even aware of the incident.
>
> Charcoal production via the vertical retort process proposed for the Barrack project has been proven to be accident free at Wundowie, where two similar retorts operated for twenty four years without major incident.
>
> If one were to seek potential accident sources related to charcoal production, spontaneous combustion of the product would be of greatest concern.
>
> Again, the fire would be restricted to the site, and the nearby population would be unaffected.
>
> Barrack Silicon is developing a programme of total loss control and accident prevention to ensure effective management of the site and eliminate the potential for industrial accidents of the kind referred to in this question."

The EPA notes that the proponent is committed to developing safety and contingency planning during both construction and operation of the plant.

5.8.6 Other issues

SUBMISSION:

Comparisons with SCM.

Various submissions sought to draw comparisons between what environmental impacts might be expected from the proponent and impacts experienced from the SCM plant at Australind. At the public meeting the Project Manager sought to distance the proponent from such comparisons. The EPA would agree. This proponent has no connections with SCM, the processes proposed are entirely different, and it is being established under new environmental legislation greatly different from that which pertained when the Laporte plant was established.

SUBMISSION:

Can the employment figures be believed?
Employment figures apply equally to other locations.

One submission claimed that employment figures "promised" at Electrona had not eventuated, and asked how believable Barrack's figures were. While employment is only peripheral to environmental assessment, it is a consideration. However, the EPA does not regard the indicative employment figures given in the PER as a commitment by the proponent.

It seems likely as suggested that location elsewhere would not greatly change the number of jobs generated by the project.

SUBMISSION:

Any instruments based on radioactive measuring devices?

Barrack replied that there were no radioactive measuring devices included in the Barrack Silicon plant planning at this point in time. In any event the regulations under the Radiological Council and DOSHWA covering the use of such devices should be adequate to ensure that the environment is adequately protected.

6. CONCLUSIONS

This proposal is very diverse and wide-ranging and has the potential to impact upon many different parts of the environment.

With regard to the mining of quartzite at Moora most of the environmental concerns have been adequately dealt with before or are addressed in commitments by the proponent, and apart from recommending additional monitoring the EPA has nothing to add to its previous assessment. The transport of the ore is now substantially by rail, and the EPA prefers this to the previous road transport.

The gathering of firewood-quality jarrah from the jarrah forest by CALM is little different from that previously approved by the EPA and no additional recommendations are made.

The PER fails to mention impacts during plant construction. This is of concern to the EPA and several recommendations are made to control adverse environmental effects.

The plant will be clearly visible, and screening and landscaping will be important to minimise the visual impact, as will properly-planned nightime lighting of the plant. The proponent has made commitments and the EPA has made further recommendations to complement these.

The major environmental impacts of the plant's operation identified by the EPA are :

. emissions of amorphous silica dust;

. emissions of noise;

. emissions of offensive odours; and

. the change in environmental amenity for nearby residents.

The EPA has recommended that the proponent should not be permitted to directly vent furnaces to the atmosphere, and considers that with the implementation of this recommendation and the proponent's commitments, this aspect of the plant's operation is environmentally acceptable.

The plant has many elements with the potential to generate annoying noise so the EPA has recommended that the proponent be required to prepare a detailed noise abatement plan and recommended stringent noise level limitations on the proponent's operations. With the implementation of these recommendations and the proponent's commitments, the EPA considers that the noise generated from the plant will be environmentally acceptable.

The EPA recommends no direct venting of the charcoal retorts in view of the highly objectionable nature of the fumes which they can produce, and requires operation of the retorts and the wood waste incinerator so as to ensure no detectable odours beyond the Picton Policy Area.The implementation of these recommendations and the proponents commitments will, in the EPA's view, ensure that no environmental problems will be caused in the surrounding residential areas due to odours from the plant.

The establishment of the plant as the first development in this new industrial area will have a significant impact on the environmental amenity of nearby residents. The EPA believes that its recommendations and the proponent's commitments with regard to the plant's operation are sufficient to ensure that the impact on environmental amenity is no greater than could reasonably be expected by the establishment of the Picton Policy Area for "general industry". Further, the EPA has recommended the formation of a community consultative committee to promote communication between the proponent and the local residents.

The EPA concludes that, subject to the implementation of its recommendations in this assessment report and the commitments made by the proponent, the project as described in the PER is environmentally acceptable.

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APPENDIX A

SUPPLEMENT TO PER ON SITE SELECTION

BARRACK SILICON PTY LTD

SUPPLEMENT TO

BARRACK SILICON PROJECT

PUBLIC ENVIRONMENTAL REPORT

JANUARY 1988

EVALUATION OF ALTERNATIVE SITES

Section 3 of the Barrack Silicon Project Environmental Report discussed the process of selection for the combined charcoal and silicon plant site.

As outlined therein, the Picton site evaluated in the Public Environmental Report was selected as the preferred option for the integrated silicon/charcoal complex as it offers a location already planned for re-zoning for heavy industry to which a more secure long term power supply can be provided with the promise of availability of power to the site in an economically viable time frame.

The land has been secured for the Project in consultation and cooperation with the South West Development Authority who have been intimately involved in the planning process for the Bunbury Region, and were in a position to provide guidance to the proponents in respect to specific planning issues and the availability of suitable industrial land at an economic cost.

The specific plant location involves the purchase of Collie Location Lots 42 and 43 on Temple Road and Lot 49 on South Western Highway an area of approximately 191 hectares. In terms of the Bunbury Region Plan (March 1987) these lots are situated within northern area A in Policy Area 5 - Picton and have direct road, railway and service corridor access to the Port of Bunbury and are ideally suited to an export-oriented general industry such as the silicon plant which requires a long term association with rail, road and port facilities.

Alternative locations within Policy Area 5 were investigated. The position of southern area B bounded by the Preston and Ferguson Rivers was found to be generally unsuitable because of the flight path and radio interference constraints of Bunbury airport, with the heights of both furnace stacks and charcoal retorts being in excess of 35 metres. The portion of southern Area B bounded by the South West Highway and the Ferguson River was found to be unsuitable. The area of useable industrial land was limited by the height restrictions associated with Bunbury Airport, the dissection of the land by the rail loop in the Picton marshalling yard area and the crisscrossing of the area by numerous drainage ditches and two major 132 kV overhead power transmission lines. Outside the rail loop and to the southeast the land consists of a series of poorly drained depressions and individual swamps and soaks overlying organic sediments. The major part of this area was so totally waterlogged it will be generally unsuited for economic development of industry similar to the silicon plant.

Land within the Davenport Area (Policy Area 6) was similarly rejected due to constraints associated with the flight path and radio interference limitations of Bunbury Airport, particularly in view of plans for expansion of Bunbury Airport in its present location possibly within five years.

Land available for development to allow industries such as the silicon plant to be sited in this area is very limited in any event by the presence of extensive wetlands and the concomitant needs for adequate foreshores and floodways along the rivers and wetlands.

The final area examined was Dardanup West (Policy Area 15). Again the land in this area consists of level to undulating sand dunes with poorly drained wetlands except for the margins of the Preston River.

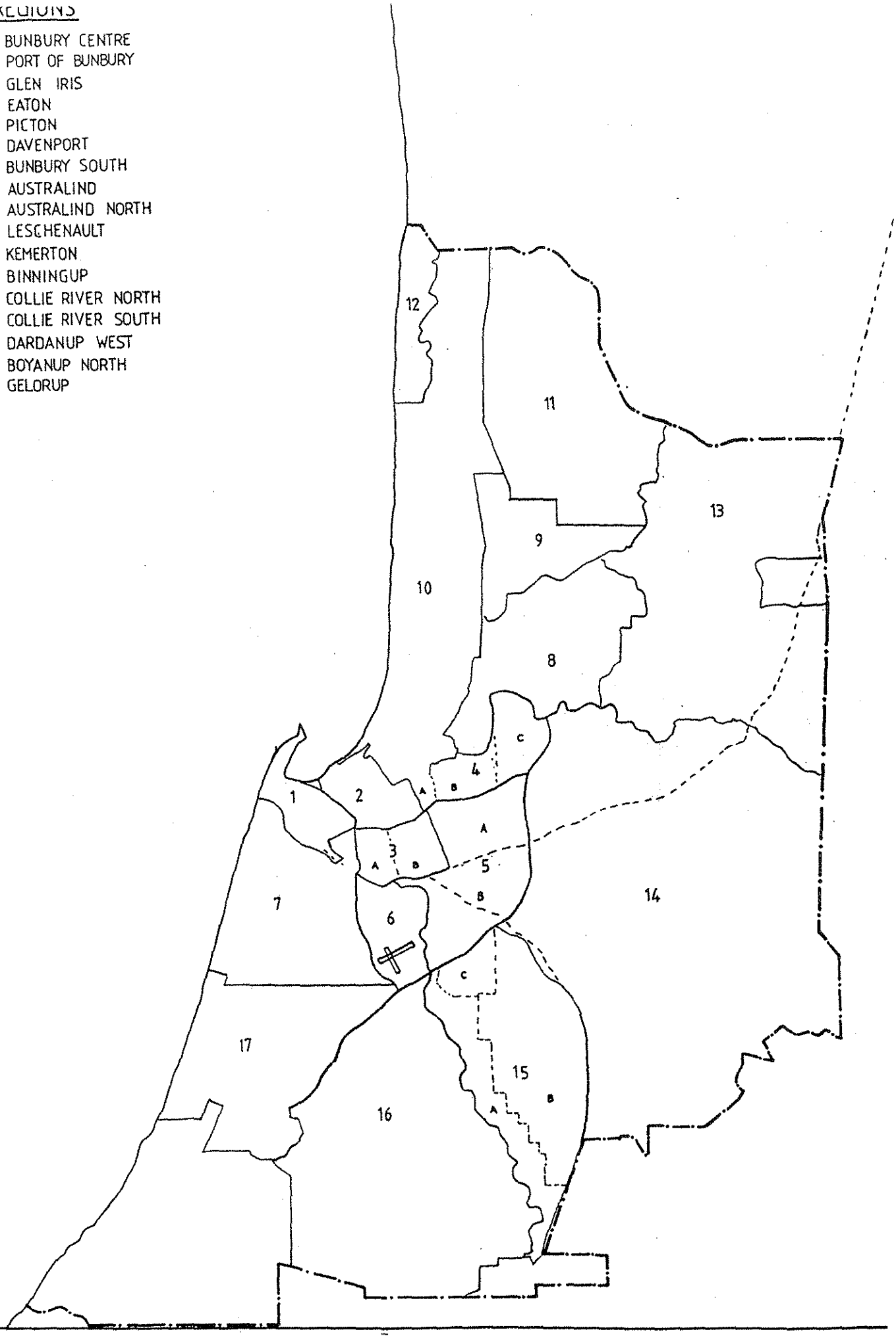
The draft Policy has split the Dardanup West Area into three precincts. Precinct A is the riverland grazing belt along the Preston River which is earmarked for agricultural purposes consistent with conservation of the environmental amenity of the Preston River system. Precinct B which is by far the largest area of land in the Dardanup West vicinity is set aside for special rural zones and sand plain grazing. Neither of the above two precincts were therefore considered in attempts to identify potential sites for the proposed charcoal/silicon plant. Precinct C represents an area of approximately 300 hectares in the northern part of the Dardanup West Area where the particle board factory, mill and resin plant have already located. A site in this area would be generally low lying and suffer from clear disadvantages in terms of its distance from rail and port services as well as the main 132 kV power transmission lines. In addition sites in this area were still uncomfortably close to the Bunbury Airport and again height and radio interference restrictions limited the area of useable land within Precinct C to the point where it was not viable on economic grounds.

In consideration of the site finally selected in Precinct A of Policy Area 5 at Picton, the proponents recognised that by judicious positioning of the plant a minimum buffer zone of approximately 1.5 kilometres was currently available from the major centre of activity on the site to the nearest existing residences in Eaton and Glen Iris. It also recognised that the concept of buffer zones as referred to in the Bunbury Region Plan was merely intended as a preliminary planning tool and that each industry should be assessed environmentally on its merits. Despite the work done by Rigden (Circa 1977) and others the proponent does not accept an automatic Class II classification in terms of Appendix A of the Bunbury Region Plan. In that respect the proponent would argue that in respect of Table 1 Appendix A its plant can be closely compared to a Steel Manufacturing Electric Furnace which is designated Class III (3).

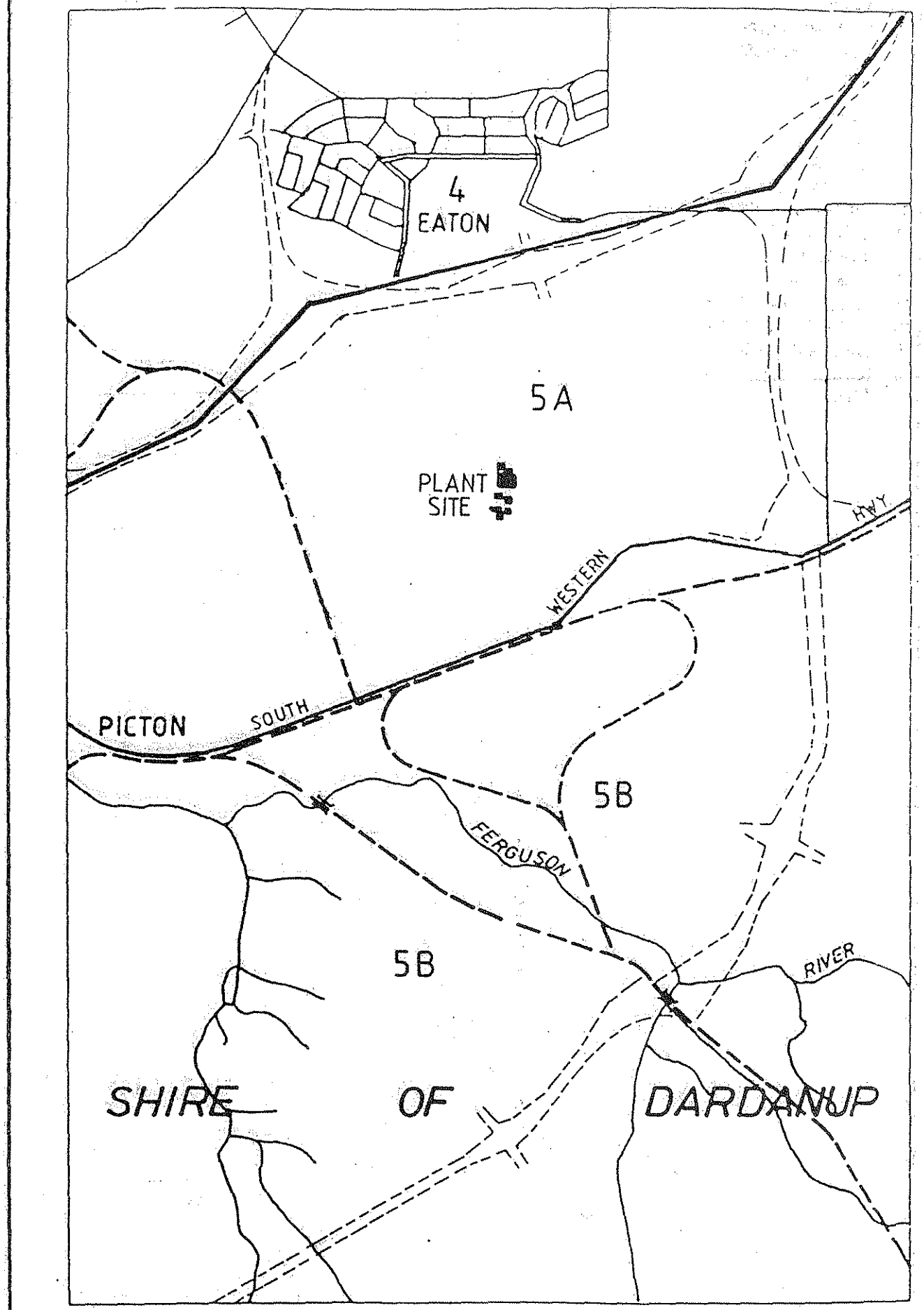
The proponent is therefore satisfied that given the constraints of time and economics associated with the Barrack Silicon Project and having consulted in advance with both the South West Development Authority and the State Planning Commission, the best available site has been selected for the proposed silicon plant industrial development.

REGIONS

1 BUNBURY CENTRE
2 PORT OF BUNBURY
3 GLEN IRIS
4 EATON
5 PICTON
6 DAVENPORT
7 BUNBURY SOUTH
8 AUSTRALIND
9 AUSTRALIND NORTH
10 LESCHENAULT
11 KEMERTON
12 BINNINGUP
13 COLLIE RIVER NORTH
14 COLLIE RIVER SOUTH
15 DARDANUP WEST
16 BOYANUP NORTH
17 GELORUP



BUNBURY REGIONAL POLICIES


4
EATON
5A
PLANT
SITE
HWY
WESTERN
SOUTH
PICTON
5B
FERGUSON
5B
RIVER
SHIRE OF DARDANUP

APPENDIX B

PROPONENT'S SILICA FUME STUDY

BARRACK SILICON PTY LTD

PUBLIC HEALTH IMPLICATIONS OF POTENTIAL AMORPHOUS SILICA EMISSIONS FROM THE PROPOSED BARRACK SILICON PLANT AT PICTON

MAUNSELL & PARTNERS PTY LTD

JANUARY 1988

Maunsell & Partners Pty Ltd

CONSULTING ENGINEERS & PLANNERS

TABLE OF CONTENTS

1. INTRODUCTION

Barrack Silicon Pty Ltd is proposing to construct a silicon production plant at Picton near Bunbury in the south-west of Western Australia. The location of the proposed plant and of the nearest urban area to the proposed plant site (ie the township of Eaton) is shown in Figure 1.

The proposal is described in detail in a Public Environmental Report (PER) prepared by Barrack Silicon Pty Ltd. Since the release of the PER concern has been expressed, by people who live in the townships nearest to the proposed plant site, that amorphous silica emissions from the plant could have an adverse impact on public health. This concern has been expressed particularly by residents of Eaton.

The level of amorphous silica emissions from the proposed plant and public health implications are discussed in the PER but Barrack Silicon Pty Ltd considers that a more detailed discussion of the issue is necessary, to alleviate local concern. The present report has been designed for this purpose. In some respects the discussion presented here differs from that in the PER as additional information obtained since the publication of the PER has been included.

2. THE NATURE OF AMORPHOUS SILICA EMISSIONS

Silicon will be manufactured at the proposed plant by heating quartzite combined with charcoal to high temperatures in two submerged arc electric furnaces. The process generates by-product silicon monoxide gas, some of which moves to the upper part of each furnace where it is converted to amorphous silica by combination with air (oxygen). A full account of the chemical processes which occur in silicon furnaces is given in the PER (Table 4.1, p16).

The amorphous silica is a very fine dust or powder which is technically known as fume. The size of individual particles of fume ranges between 0.01 microns and 1.00 microns. The term amorphous indicates the non-crystalline nature of the particles which are round and smooth in appearance.

There are other types of amorphous silica (namely diatomaceous earth, precipitated, and silica gel) but these differ from fume in terms of their health implications and are not produced in the silicon process proposed for Picton. These other types are not considered further in this report and any reference to amorphous silica below refers specifically to fume.

3. FUME COLLECTION AND ATMOSPHERIC EMISSIONS

3.1 STANDARD OPERATIONS

In normal operating conditions, the exhaust gas and the entrained amorphous silica fume will be collected by hoods over the top of each furnace and over the furnace tapping areas and will be ducted to a baghouse. The baghouse contains a large number of especially coated fibreglass filter bags in sixteen compartments. The bags trap the fume as the gas passes through the baghouse and a filter cake of fume develops which further increases the filter efficiency.

Manufacturers' data supplied to Barrack Silicon by Mannesman Demag of West Germany and the Pittsburgh Engineering Corporation USA both claim baghouse efficiencies of 99.9%. At Picton, an estimated 8,000 tonnes of fume will be collected each year from the baghouse and will be sold as an additive to cement. With experience, Barrack Silicon believes fume production will be progressively reduced to about 4,000 tonnes annually, as furnace efficiency and hence the recovery of silicon metal is improved.

The remaining 0.1% of the fume entering the baghouse is not captured by the filters and escapes with the furnace off-gas as atmospheric emissions. It is estimated that at Picton the normal level of emission will be less than 5mg per cubic metre of off-gas ($5mg/m^3$). This will be discharged to the atmosphere through a slot vent along the whole length of the baghouse roof.

3.2 NON-STANDARD OPERATIONS

For short periods the silicon plant will operate under non-standard conditions which will cause an increased level of fume emission. During periods of baghouse maintenance and following the replacement of filter bags, the baghouse will operate at less than optimal conditions. At these times, the baghouse emissions may increase to a maximum of $50mg/m^3$. These events will be brief.

On occasion it will also be necessary to bypass the baghouse and to let the furnace gases and all of the entrained fume escape directly into the atmosphere. This may occur during scheduled events such as equipment inspection and minor repairs, or during unscheduled events such as equipment failure. At these times the estimated quantity of fume in the off-gases during scheduled events will be $2,000mg/m^3$ and the load during unscheduled events will be $3,500mg/m^3$.

Estimates of the frequency and duration of direct venting from the furnaces can be made on the basis of operating experience. These are as follows:

(1) Scheduled furnace venting

Extended general inspection - maximum duration 2 hours total/year
Minor repairs - maximum duration 40 minutes, maximum annual total 24 hours
Maximum of all events 26 hours per year

(2) Unplanned furnace venting caused by electrode breakage or other equipment malfunction may not occur at all, but is not likely to exceed a total of 24 hours in any year. Any such ventings will consist of events of less than one hour duration

4. ATMOSPHERIC DISPERSION OF AMORPHOUS SILICA FUME

4.1 INTRODUCTION

Analyses are required in order to predict whether and to what extent the amorphous silica emissions described in Section 3 above will affect people living close to the proposed Picton plant site. These analyses consist of the following:

(1) Theoretical calculations of the ground level concentrations of amorphous silica fume at various distances from the plant under differing wind speeds and atmospheric stability conditions.

(2) Interpretation of local weather patterns, and in particular, the frequency of winds liable to carry emissions from the plant towards nearby residences, and the occurrence of wind speeds and atmospheric stability conditions likely to promote ground level deposition (ie fall-out) of fume.

These analyses must take account of both standard and non-standard operation of the plant.

4.2 THEORETICAL CALCULATIONS

The dispersion of amorphous silica fume from the proposed plant at Picton will depend on a large number of factors as follows:

Emission Characteristics:
- amount of fume in the off-gas
- volume of off-gas
- temperature of off-gas
- exit velocities
- height of the baghouse or furnace vents

Atmospheric Conditions:	wind direction and speed presence of inversions and inversion height
Physical Conditions:	presence of nearby buildings surface topography around the plant.

Standard computer programmes have been used to model the dispersion of fume. In particular, these predict what concentrations of fume can be expected at ground level at various distances around the plant and under varying wind speeds and atmospheric stability conditions (Steedman Limited, 1987).

These calculations are presented in the PER as one hour averages, that is as concentrations that may occur over short time intervals.

The range of ground level concentrations of amorphous silica at a distance of 1.5km from the proposed plant under various operating conditions are as follows:

Standard Operations:

(1) Baghouse emission at 5mg/m^3

One hour average 0 to 0.003mg/m^3

Non-standard Operations:

(2) Baghouse emission at 50mg/m^3

One hour average 0 to 0.03mg/m^3

(3) Scheduled furnace emission at 2,000mg/m^3

One hour average 0 to 0.5mg/m^3

(4) Unscheduled furnace emission at 3,500mg/m^3

One hour average 0 to 0.89mg/m^3

4.3 INTERPRETATION OF LOCAL WEATHER PATTERNS

The township of Eaton is used as an example in this Section as it is the nearest significant urban area to the proposed plant site. A similar analysis could be made for the proposed Glen Iris subdivision or for residences at Picton.

The proposed plant is 1.5km from the closest boundary of Eaton so the data presented in Section 4.2 above indicate the ground level concentrations that may theoretically occur at this locality. It is now necessary to estimate what the actual exposure at Eaton may be. To do this, local weather patterns must be taken into account.

The critical factor which will determine whether amorphous silica emissions result in measurable effects occur at Eaton is wind direction. Wind records are available from three nearby locations:

(1)	Bunbury Post Office (7km west of the proposed plant site)	1965-1985
(2)	Glen Iris (2km west)	1982-1983
(3)	Australind (6km north)	1981-1985

Although the Glen Iris data cover only one year, comparisons with the Australind data (4 years) have demonstrated that they are representative of the period 1981-1985 (Pitt et al., 1985). The Bunbury records (20 years) also exhibit the same seasonal trends. Therefore, as the various data are consistent and Glen Iris is closest to the proposed plant site, the latter were used for the purposes of this report.

The location of the plant site relative to Eaton is shown in Figure 1 together with trajectories from the plant for four wind direction classifications. Southerly (S) and south-south-easterly (SSE) winds would tend to carry emissions in a direct path over Eaton while for south-south-westerly (SSW) and south-easterly (SE) winds the centre of the emissions plume would tend to travel in a direction passing either side of the Eaton township. Allowing for horizontal plume spread and plume meander the SSW and SE winds have the potential depending upon emission strength to cause measurable dust levels over some part of the town.

A summary of the wind data from Glen Iris is given in Figure 2. These data indicate that winds blowing in the general direction of Eaton occur for about 33% of each year (approximately 4 months), as follows:

Primary Directions	% Occurrence
S	8.0
SSE	9.5
Marginal Directions	
SSW	6.0
SE	9.5
Total	33.0

For most of this time the Picton plant would be generating standard emissions from the baghouse (5mg/m^3). However for brief periods, the baghouse emission levels may increase up to a maximum of 50mg/m^3.

It can also be assumed that some periods of direct venting of fume from the furnaces could also affect Eaton during this 4 month period. These events are of particular importance as they define the highest ground level concentrations that could occur.

It has been been estimated that scheduled furnace venting will occur for up to 26 hours each year in periods of up to 40 minutes duration. If these events are randomly distributed throughout the year, then they will coincide with wind directions towards Eaton approximately 33% of the time. This represents a maximum total of 8.58 hours (33% of 26 hours) or approximately 13 x 40 minute events. At these times the ground level concentration at Eaton would be between $0mg/m^3$ and $0.5mg/m^3$ (1-hour average) depending on the wind speed and atmospheric stability conditions.

To some extent it may be possible to schedule these furnace emissions for times when Eaton is less likely to be affected. For example, the monthly occurrence of winds towards Eaton is shown in Table 1. These data indicate that these winds occur most often in spring and summer, and especially from October to February. They are less common from May to July due to the prevalence of cold fronts. Therefore, if regular events which involve furnace emissions (such as extended general inspections) are scheduled for winter there will be less likelihood that Eaton will be affected.

Similarly comparison of morning and afternoon wind roses for Bunbury reveal a persistent shift in wind direction during the day. During spring and summer the most common wind direction changes from SE in the morning to SW in the afternoon. This reflects the development of an afternoon sea breeze during these months. Therefore, if furnace ventings were scheduled in these months for the afternoon rather than the morning the emissions would have less likelihood of affecting Eaton.

Such management of furnace emissions would not be possible with unscheduled furnace emissions. The yearly occurrence of unscheduled furnace emissions may vary from none to a maximum of 24 hours made up of events of less than 1-hour duration. The maximum effect on Eaton due to such emissions can be estimated in the same manner as the scheduled furnace emissions above.

If it is assumed that 24 hours of unscheduled furnace emissions occur in a year and that the individual events are randomly distributed, the total exposure of Eaton will be 33% of 24 hours which is 8 hours. In this time, the ground level concentration at Eaton will approximately be in the range $0mg/m^3$ to $0.89mg/m^3$ (1-hour average).

TABLE 1

MONTHLY SUMMARY OF FREQUENCIES OF WIND DIRECTIONS AFFECTING EATON FROM THE SMELTER SITE. CORE AND MARGINAL WIND DIRECTIONS ARE AS DEFINED IN THE TEXT.

DATA FOR GLEN IRIS FOR JULY 1982 TO JULY 1983.
Source: Pitt et al (1985)

Month	Core %	Marginal %	Both %
January	26.5	24.0	50.5
February	19.0	15.5	34.5
March	13.0	18.5	31.5
April	14.5	15.5	30.0
May	7.0	10.0	17.0
June	9.0	9.5	18.5
July	6.5	10.0	16.5
August	12.0	19.0	31.0
September	19.0	14.5	33.5
October	28.0	14.0	42.0
November	24.5	15.5	40.0
December	23.0	18.0	51.0

5. EXPOSURE STANDARDS

5.1 AMORPHOUS SILICA FUME STANDARDS

The significance of the potential level of exposure of Eaton residents to amorphous silica fume described in Section 4.3 may be evaluated by comparisons with published health standards. Such standards are of two types:

(1) for occupational health, and
(2) for public health

The occupational health standards (sometimes referred to as threshold limit values or TLV's) indicate the maximum concentration to which a worker within a silicon plant may be continuously exposed for 8 hours a day, 5 days a week for their working life without adverse health effects.

The Australian National Occupational Health and Safety Commission has recently published (November 1987) draft occupational health standards for silica fume at $2mg/m^3$. This standard is also applied in Norway (Scancem, 1984).

Unfortunately, no public health standards have been published for amorphous silica fume. Therefore, Barrack Silicon proposes an annual average standard at one-thirtieth of the occupational health standard. This ratio has been applied to various substances by State authorities in the USA and is frequently used as a rough guide.

Public health standards are always substantially less than those for occupational health as it is assumed that a person living close to an industry may be continuously exposed to an emission for 24 hours a day, 7 days a week for their entire life. Moreover, a variety of different types of person may actually be involved with different sensitivity to the emission such as children, the elderly, nursing mothers etc.

In Australia, the only public health standards for amorphous silica fume are apparently those adopted by the Tasmanian authorities for a silicon plant at Electrona near Hobart. In this case the plant operators suggested that the standard should be one-tenth of the occupational standard. They considered fume to be a nuisance dust and adopted the then occupational standard of the American Council of Government and Industrial Hygienists (ACGIH) for such dust ($5.0mg/m^3$) as their reference. This gave a public health standard of $0.5mg/m^3$ as a one-year average.

In the PER for the Barrack Silicon Project, the same procedure was adopted. In this case, the contemporary ACGIH occupational standard for nuisance dusts was $10mg/m^3$ but this was divided by thirty to give a more stringent public health standard of $0.3mg/m^3$ one-year average. Although the procedure of dividing the occupational standard of a substance by 10 or by 30 has been adopted for various substances by US state authorities, no specific instance of its official application to amorphous silica fume has been located by our research.

In view of the recently published Australian draft occupational standards cited above, the standard suggested in the PER needs to be revised in order to maintain consistency with Barrack Silicon's previously adopted stringent standards with regard to occupational and public health matters associated with this project. Using the same division approach, the proposed standard is:

$2mg/m^3$ divided by 30 = $0.07mg/m^3$ (annual average)

For some emissions, the public health standards may also include a maximum exposure limit which must not be exceeded for even short periods. However, as chronic exposure is the main concern with amorphous silica fume (see Section 6 below) no specific short-term maximum limits appear to have been published. Therefore, Barrack Silicon proposes that the World Health Organisation's guidelines for total respirable dust should be adopted as a standard for short term exposure. These are 0.10 to $0.15mg/m^3$ (24 hour average).

5.2 COMPARISON OF STANDARDS WITH PREDICTED EXPOSURE LEVELS

The public health standards proposed in Section 5.1 above can be used to evaluate the significance of a worst-case exposure scenario for Eaton. To reiterate, the standards are:

24 hour average	$0.10\ mg/m^3$
Annual average	$0.07mg/m^3$

The proposed worst-case 24 hour exposure scenario is as follows:

(1) 21 hours of maximum exposure levels associated with baghouse emissions at $50mg/m^3$, ie 21 x $0.03mg/m^3$

(2) 2 hours of maximum exposure levels associated with scheduled direct furnace emissions due to an extended plant inspection, ie 2 x $0.5mg/m^3$

(3) 1 hour of maximum exposure associated with unscheduled furnace emissions due to equipment malfunction, ie 1 x $0.89mg/m^3$.

This scenario is an extreme worse-case and has a very low probability of occurrence. The average 1 hour exposure during this 24 hour period would be:

$$\frac{(21 \times 0.03) + (2 \times 0.5) + (1 \times 0.89)}{24}$$

that is, $0.105mg/m^3$

On this basis, it can confidently be concluded that there is extremely little likelihood that the proposed 24 hour average of $0.10mg/m^3$ will be exceeded at Eaton.

The proposed worst-case annual exposure scenario is as follows:

(1) 2991.5 hours of maximum exposure levels associated with baghouse emissions at $50mg/m^3$, ie 2991.5 x $0.03mg/m^3$

(2) 8.5 hours of maximum exposure levels associated with scheduled direct furnace venting, ie 8.5 x 0.5mg/m^3

(3) 8 hours of maximum exposure levels associated with unscheduled direct furnace ventings, ie 8 x 0.89mg/m^3

(4) 5832 hours of nil exposure

Items (1) to (3) in this scenario represent the 4 months during which wind and other conditions are such that Eaton is likely to be affected, while item (4) represents the other 8 months when there is no effect.

This scenario is again an extreme worst-case with a very low probability of occurrence. The average 1 hour exposure during this hypothetical year would be:

$$\frac{(2991.5 \times 0.03) + (8.5 \times 0.5) + (8 \times 0.89) + (5832 \times 0)}{8760}$$

that is, 0.011mg/m^3

As the proposed annual average standard is 0.07mg/m^3, it can again be concluded that the proposed Picton Plant will not produce ground level concentrations of fume at Eaton which exceed the proposed stringent standards.

5.3 CRYSTALLINE SILICA CONTAMINATION

Some researchers have established that specific samples of amorphous silica fume may be contaminated with crystalline silica and specifically with cristobalite (Johnson et al., 1973; Vitums et al., 1977). Chronic exposure to crystalline silica and particularly the form known as cristobalite presents a more serious potential of adverse health effects than does amorphous silica fume. Accordingly, published occupational health standards for these substances are more stringent. For example, the occupational standards of the ACGIH (1986-87) and the National Occupational Health and Safety Commission of Australia (draft, 1987) are:

Crystalline quartz	0.1mg/m^3 respirable dust
Cristobalite	0.05mg/m^3 respirable dust

It follows that public health standards would need to be much more stringent for these substances than those for amorphous silica fume.

This subject is discussed further in Section 6 below.

6. HEALTH EFFECTS OF AMORPHOUS SILICA FUME

Prior to the introduction of appropriate occupational health standards, long term exposure to crystalline silica in enterprises involving the drilling, quarrying and crushing of quartz has been a major cause of occupational lung disease in these particular industries (Irving Sax 1984). The lung disease is specifically known as silicosis and is characterised by fibrotic changes (scar tissue) and symptoms which include shortness of breath and reduced capacity for exertion. The dust is only hazardous if it is respirable, that is less than 5 microns in size.

While the association between crystalline quartz and silicosis is well established, the potential for amorphous silica fume to cause similar fibrotic changes in the lungs has been a matter of considerable debate.

The available information on fume comes from three types of study as follows:

(1) Experimental tests on macrophages taken from animals (special cells which have the ability to absorb and remove dust particles from the lungs)

(2) Experiments involving exposure of test animals to dust

(3) Assessments of workers in the silicon industry

Davies (1981) examined the effects of fume on macrophages obtained from mice and found a toxicity equivalent to that of crystalline silica. However, he cautioned that 'great care' must be taken in extrapolating these results to living animals. The fume used was also not obtained from an electric arc furnace but by high temperature decomposition of silicon tetrachloride (products known as Cab-o-Sil and Aerosil).

Similarly, Groth et al (1981) demonstrated fibrotic changes in the lungs of monkeys exposed to Aerosil at an average daily level of 9.9mg/m^3 for 5-6 hours each day, 5 days a week for 13 months. However, these authors are also cautious in their conclusions as follows: "Because of the paucity of pulmonary function data on monkeys and comparisons with human data, no quantitative extrapolation to the clinical significance of these findings in humans can be made at this time." (p137)

In earlier work Swensson (1967) also found fibrotic changes in the lungs of rats after intratracheal injections of 40mg of fume. These changes were markedly less than that caused by crystalline silica and reached a maximum one month after injection. The fume also contained small amounts (less than 1%) of crystalline silica.

Similarly Johnston et al (1973), using basically the same methods as Swensson found lung damage equivalent to that caused by crystalline silica. Analysis of the fume used in this case revealed that it consisted of a cristobalite core covered by amorphous silica. Cristobalite is a form of crystalline quartz that is known to be particularly fibrogenic. Therefore, whether the observed results were due solely to the cristobalite cannot be determined.

Swensson (1967) also points out that fume on leaving the furnace may also carry fine quartz particles from the charge. This potential contamination has not only caused some difficulty in the interpretation of results but has also led some authors to suggest that fume should have the same occupational and public health standards applied to it as crystalline silica (Johnston et al, 1973; Wnekowski, 1986). However, contamination with crystaline silica is apparently exceptional rather than inevitable, and may be a function of the nature of the quartz charged to the furnace.

In this respect Jahr (1981) states that: "This type of amorphous silica consists of extremely small, spherical particles with fairly low contamination of other substances [and which do] not produce X-ray patterns typical of crystalline substances." (p200). Similarly Iler (1981) comments: "All of these silicas are amorphous and exhibit no definite X-ray diffraction lines, although possibly some crystallinity may be found in some pyrogenic silicas (ie fume) made by the hottest processes and not cooled quickly enough."

The difficulty also occurs in studies of workers in the silicon industry. Vitums et al (1977) found fibrotic changes in the lungs of three men employed in a silicon plant and indications of lung damage in a further eight out of a total of forty men studied. The eight were not intensively assessed and the nature and cause of the abnormalities were not determined. He concluded that: "From the observations reported in this paper, it would appear that some degree of nodular and fibrotic lung disease can result from chronic exposure to this particular amorphous silica dust." (p67).

However, Vitums et al (1977) noted that a sample of this dust contained 6-7% of crystalline silica. Gross (1977) comments that: "This amount of crystalline silica in lung tissue is quite sufficient to cause the nodular fibrosis pictured and described in this report." (p100).

Jahr (1981) is of the same view: "Vitums et al (1977) claimed to have found pulmonary fibrosis from amorphous silica dust, a product of silica vapor. However, X-ray analysis showed that the dust contained crystalline silica, and the exposure was short (less than two years). It is therefore highly unlikely that the amorphous silica involved could have caused these cases of silicosis." (p202).

On the other hand, Brambilla et al. (1980) found lung damage among workers exposed to fume for between 7 and 35 years in a silicon metal plant and comment: "This (damage) differs from silicosis. In our observations, as in those of Vitums, the quantity of crystalline silica is very low and cannot be held responsible. The fumed amorphous silica appears therefore to be the cause."

Jahr (1981) presents the most comprehensive survey available of studies of workers at ferrosilicon and silicon plants. It is therefore worth quoting at length.

"There are conflicting reports on the risk of silicosis among ferrosilicon operators. Fehnel (1944) did not find a single case of silicosis at American ferrosilicon plants. Pancheri (1948) found slight fibrosis, but no silicosis among the workers at ferrosilicon plants. Re-examining Pancheri's material, Radica (1956) was also only able to show reticulation, which had increased in two cases. Neither Drees and Jung (cited in Swensson et al. 1971) nor Roberts (1965) have detected silicosis among ferrosilicon workers, in spite of an exposure which was described thus: The fumes of amorphous silica came up in great clouds and when flocculated settled on the rafters like snow drifts.

Broch (1953) claimed that he found 29 cases of silicosis and 30 suspect cases among 208 workers at Norwegian plants. Five of the cases had worked in a quartz quarry or in the quartz-crushing department. One person had worked for 8 years in a foundry before working 8 years in the ferrosilicon furnace-house. Unfortunately, the dust samples collected from the workplace atmosphere were only analysed chemically, so the possible content of crystalline silica is unknown. However, samples collected from the chimney showed no quartz X-ray diffraction patterns (Debye-Scherrer). The author says that "the ferrosilicon furnace-houses offered dusty work with quartz, iron, coke, and ash from coke", but considered it unlikely that this work could have been of any great importance.

Glomme and Swensson (1965) studied 865 workers from Norwegian and Swedish ferrosilicon smelting plants. They found 17 cases where the change in lung tissue corresponded to silicosis. Of these, four had worked in the atmosphere of the furnace-house; these four had slight changes on the lungs. The authors concluded that the risk of lung dust disease due to the furnace-house atmosphere itself seems to be moderate.

Bruce (1937) was first to claim the occurrence of silicosis in the manufacture if silicon alloys. Among a total of 64 workers in two small smelting plants he claimed to have found 10 cases of silicosis. These cases were thoroughly re-examined by Swensson et al (1971) with the result that the diagnosis of silicosis could be maintained only in one of the cases. At autopsy the changes were found to have been slight and could not explain the clinical picture. In six of the cases the changes were transient and could not be demonstrated by X-ray examination made seven to eight years later."

Jahr (op.cit.) also reviews most of the animal studies cited above. He concludes that these particular studies suggest that "... one cannot rule out the possibility of a long term effect when persons are exposed repeatedly day after day, to amorphous silica." (p207).

He continues "The follow-up studies by Swensson and his co-workers indicate that the risk in ferrosilicon works is small, in spite of partly heavy exposure to amorphous silica, which sometimes also contains small amounts of quartz. There seems to be no doubt that the truly amorphous silicas have far less effect on the lungs and lymph nodes than the crystalline silicas." (p207).

Finally, on the basis of the animal experiments in particular, Jahr recommended a conservative occupational health standard of 2mg/m^3, which is the same as that recently recommended by the Australian National Occupational Health & Safety Commission (Section 5.1 above).

Since Jahr's review, Robalo-Cordeiro et al. (1985) have also published findings which implicate amorphous silica fume as a cause of lung damage among workers at silicon plants.

7. SUMMARY CONCLUSIONS

It is important to note that the observed laboratory and clinical observations relative to occupational health aspects of amorphous silica have occurred either after the administration of very large doses of fume to experimental animals, or after long term exposure of workers to suspected high dust levels working in old plants; probably with minimal or antiquated dust collection systems. Matters of public health impacts were not at issue.

Dr. Wnekowski, in a 1987 publication relative to her research into fume effects upon workers is quoted as commenting "We can't say the community is at risk, because the levels would not be high enough to cause problems, but the workers could have cause for concern if the so-called nuisance dust level is too high, or they are exposed to it for too long." She is also credited with saying that it would be years before any worker contracted silicosis and this would be extremely unlikely.

On the basis of the literature review in Section 6 above, these comments are an accurate summary of the risks associated with amorphous silica fume.

Similarly, based upon the occupational health implications reported in the literature, regulatory authorities have progressively set more stringent industrial site standards for amorphous silica emissions.

For these reasons Barrack Silicon Pty. Ltd. proposes to apply the latest Australian National Occupational Health and Safety Commission Standard of 2.0mg/m^3 to the project. In addition, it is proposed that stringent public health standards be applied to the project as follows:

24 hour average	0.10mg/m^3
Annual average	0.07mg/m^3

All of the available evidence indicates that such standards will adequately protect the health of people living in the vicinity of the plant.

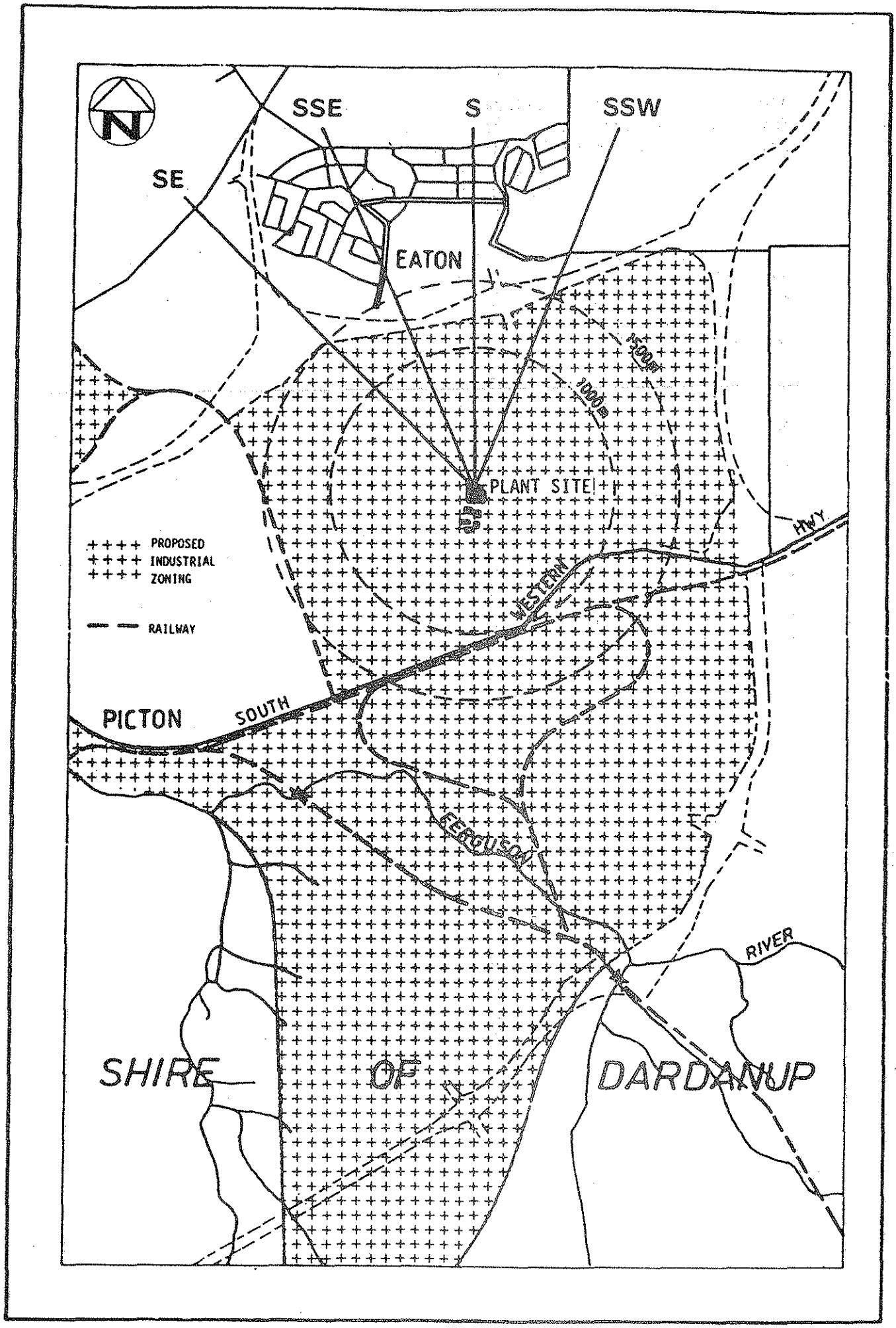
Estimates of the actual worse case exposure scenarios over 24 hour and annual periods at Eaton, have also been provided. These clearly indicate that the plant will be capable of operating within the proposed standards.

Therefore, it can be concluded that at most the silica fume emissions from the proposed plant may present short periods of nuisance (ie annoyance) dust levels in the town. Even this is questionable, as the maximum ground level concentration of fume at Eaton under all conditions ($0.89mg/m^3$) is a very small amount of dust which probably would not be noticeable.

This conclusion is consistent with that presented in the Barrack Silicon PER although in that document the proposed standard was not as stringent and, due to an overestimate of the distance between the town and plant site, the predicted ground level concentrations at Eaton were less than those given here.

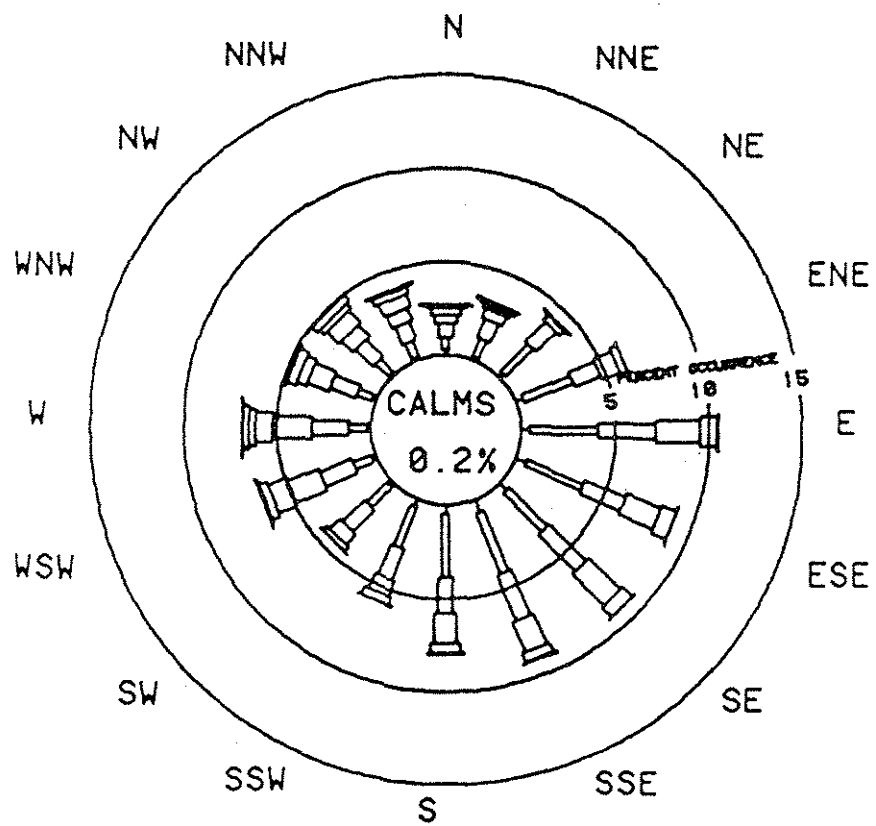
However, it needs to be recognised that the predictions provided in this report are hypothetical and need to be verified by an air quality monitoring programme. This programme should include collection of regular samples from both Eaton and Glen Iris so that residents can be provided with accurate information on the dust levels which they are being exposed to.

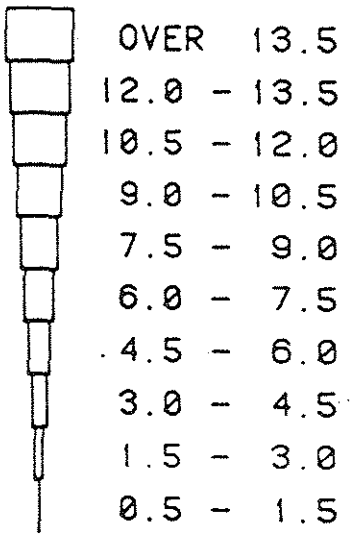
Similarly, the possibility of fume being contaminated by crystalline silica needs to be specifically examined by X-ray diffraction analysis of regular samples from the plant. Barrack Silicon has advised that such a sampling programme would be implemented for commercial as well as environmental reasons, as purchasers of the fume will require it to be free of crystalline silica.



PLUME TRAJECTORIES CORRESPONDING TO WIND DIRECTIONS SHOWN

FIGURE 1





WIND ROSE FOR GLEN IRIS
DATA PERIOD: 14/7/82 TO 13/7/83
SAMPLING TIME: 60 MINUTES
DATA RECOVERY: 92.3%

ANNUAL MEAN WIND ROSE FOR GLEN IRIS Source: Pitt et al. (1982) **FIGURE 2**

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APPENDIX C

FURTHER COMMUNICATIONS FROM PROPONENT

BARRACK SILICON
PTY. LTD.
THIRD FLOOR, 22, MOUNT STREET,
PERTH, WEST AUSTRALIA, 6001.
TELEPHONE: (09) 321 8199 FACSIMILE: (09) 321 4268

Our ref: W2728/DMS/sml

22 February 1988

Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Attn: Mr J Malcolm

Dear Jim

Pursuant to your query of 4 February regarding the use of petroleum coke in the production of silicon in the electrical arc furnace process; with particular emphasis on the intentions of Barrack Silicon Pty Ltd at the Picton site, I offer the following comment:

Petcoke is a common additive to many silicon production facilities where other superior reductants are less available; and in applications where premium quality silicon product is not a fundamental objective of the operation. Both of the above cited criteria do not apply to the Barrack Silicon Project which i) has prime eucalypt charcoal available in abundance, and ii) has premium quality silicon as its principal marketing target/ revenue course.

Those reductants most applicable to electric arc furnace silicon applications must have the following properties:

a) Low ash content, for the processes is basically a non-slagging procedure. Iron, aluminium and calcium are particularly undesirable contaminants, but any metallic oxides are considered undesirable for they will reduce in the furnace atmosphere and incorporate themselves in the silicon product.

b) Good reactivity with S_1O_2 in the process.

c) High fixed carbon content.

d) Low electrical conductivity at elevated temperatures.

e) Stability of granulometry and low decrepitation characteristics.

f) Well sized structure at delivery with a minimum of fine grained material.

Although petroleum coke satisfies many of the above listed criteria it has a particularly low reactivity with silicon (S_1O_2) and as a consequence is not a favoured reductant with silicon producers, particularly when compared with eucalypt charcoal.

Dubrous and Septier have ranked possible reductants according to their decreasing order of reactivity as indicated in the following table:

RANK	REDUCING AGENT	REACTIVITY
1	Charcoal ex Eucalyptus	High
2	Charcoal ex European timber	
3	Wood Chips	
4	Open Burning Coal	
5	Charcoal ex tropical timber	Medium
6	Lignites and Peats	
7	Peat Coke	
8	Lignite Coke	
9	Electrometallurgical Cokes	
10	Anthracites	Poor
11	Green Petroleum Coke (uncalcined)	
12	Metallurgical Cokes	
13	Calcined Petroleum Cokes	

Uncalcined (green) petcoke is the superior of the two petroleum coke alternatives because it is moderately more reactive than the calcined variety, and of somewhat lower conductivity.

However, because of the low reactivity of uncalcined petcoke and its higher electrical conductivity the maximum use of the material in any furnace is limited to 30% of the reductant charge.

In practice Barrack Silicon envisages the utilisation of petcoke during periods of start-up, commissioning or optimising furnace reaction following extended power outages or major maintenance for the presence of petcoke tends to slow the furnace reaction; thereby allowing the operators time to balance and optimise the process as petcoke is gradually deleted from the reductant feed mix.

A comparison between Barrack's conventional reductant charge mix (charcoal and woodchips) and an alternative control mix (containing petcoke) is illustrated below:

	Standard Operation Normal Mix Kg/tonne silicon produced	Control Operation Petcoke Additive Kg/tonne silicon produced
Quartz	2,479	2,530
Charcoal	931	766-880 (range)
Petcoke	0	193-197 (range)
Woodchips	751	940
	4,161	4,488

In the case of the control operational mix (containing 10% petcoke in the reductant feed) petcoke is only 4.3% of the furnace charge, but its addition also increases the percentage of reductant to the total furnace charge from 40.4% to 43.6%; to the operation cost disadvantage of the Barrack Silicon plant.

In conclusion, Barrack Silicon will use a minimum amount of petcoke for:

1. It is a more expensive imported reductant alternative.
2. It is a less efficient reductant alternative.
3. It can be expected to contain higher levels of metallic contamination in its ash than the eucalyptus charcoal and woodchips available to the project.

Barrack Silicon will be exerting its best efforts to minimise and, if feasible, eliminate the use of petcoke in its furnace consistent with its commitments to a safe and economic operation which is both environmentally and quality conscious.

Yours sincerely

C. L. Cockman

p.p. D M SPRATT
PROJECT MANAGER

BARRACK SILICON
PTY. LTD.
THIRD FLOOR, 22, MOUNT STREET,
PERTH, WEST AUSTRALIA, 6001.
TELEPHONE: (09) 321 8199 FACSIMILE: (09) 321 4268

Our ref: W2729/DMS/sml

22 February 1988

Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Attn: Mr J Malcolm, Environmental Officer

Dear Jim

During the 4 February 1988 informal meeting between personnel from the EPA and Barrack Silicon, a question relating to the nature of night lighting at the plant arose. Although Barrack is still examining engineering detail with respect to plant lighting, I can offer the following comment with respect to developments to date.

Plant facilities that will be operational on a 24 hour basis, or require illumination are:

1 The charcoal retorts, including the loading of wood to the retorts and the removal of product to stockpile.

2 The silicon furnaces.

3 The baghouse.

4 The docking mill - 2 shift operation.

These areas, and offices/control rooms, etc, will be illuminated internally and externally to meet the required safety standards and the requirements of the tasks to be performed.

The main entrance and plant access roads will be illuminated for security purposes.

Typical lighting levels will be:

1	Material handling	: 50-200	Lux
2	Conveyors	: 32	Lux
3	Security gates	: 100	Lux
4	Open areas	: 20	Lux

The above should be regarded as preliminary information based on a limited amount of detailed design.

I trust, however, that the above information does indicate that Barrack Silicon Pty Ltd is aware of its obligations with respect to plant lighting, and is working towards solutions which will meet all requirements/standards. Overall project design is currently estimated to be around 25% complete; more detailed definition of plant lighting will be available by approximately mid-May 1988, by which time detailed design should be at least 70% completed. This assumes no slippage of programme caused by delay in EPA/Government approvals since the degree of further expenditure on design work will obviously be dictated by the timing of granting of approvals for the project to proceed.

Please do not hesitate to contact either Don Adair or myself if you have further questions in relation to this matter.

Yours sincerely

C.K. Cockman

p.p. D M SPRATT
PROJECT MANAGER

BARRACK SILICON PTY. LTD.
THIRD FLOOR, 22, MOUNT STREET,
PERTH, WEST AUSTRALIA, 6001
TELEPHONE: (09) 321 8199 FACSIMILE: (09) 321 4268

Our Ref: W2720/DMS/CLC

17 February 1988

Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Attn: Mr J Malcolm

Dear Mr Malcolm

RE: SILICON PLANT LOCATIONS

Attached please find a list of silicon smelter locations worldwide. Based on advice from Mannesmann Demag (the suppliers of the furnaces to the Barrack Silicon project) and our own personal knowledge we have included the distances in kilometres for each of these smelter locations from

(a) the nearest residential housing of any kind

(b) the nearest grouping of residential housing (at least 100 residential dwellings) which constitutes a village, township or suburb within a city where applicable

You will note from this table that a total of 24 plants covering annual production capacity (predominantly in silicon) of 559,000 tpa, are an average of 0.13km from the nearest housing, and an average of 0.6kms from the nearest grouping of housing which would constitute a village, town or suburb. The proposed Barrack Silicon location at Picton compares very favourably with most of the listed locations. While there are other Silicon Smelters which are more distant from residential areas, there are certainly no grounds for suggesting that the plants located closer to residential housing cause significant environmental impacts in these locations.

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Yours faithfully

D M SPRATT
PROJECT MANAGER

cc: Mr B Carbon, Chairman Environmental Protection Authority
Mr R A Field, Director Evaluation Division
Mr D Gardiner, Department of Resources Development
Mr K Strapp, South West Development Authority

LIST OF SILICON SMELTER LOCATIONS
INCLUDING APPROXIMATE DISTANCES
FROM NEAREST RESIDENTIAL HOUSING

1 UNITED STATES

World's largest producing country for silicon metal. Production capacity exceeds 130,000 tpa.

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Globe Metallurgical Inc	Selma, Alabama (20,000 tpa)	1.5 km	5.0 km
Globe Metallurgical Inc	Beverley Ohio (12,000 tpa)	0.5 km	1.5 km
Elkem Metals Co	Alloy, West Virginia (51,000 tpa)	0.2 km	1.0 km
Reynolds Metals Co	Sheffield, Alabama (16,000 tpa)	0.3 km	1.0 km
Dow Corning Corporation	Springfield Oregon (12,000 tpa)	0.1 km	0.2 km
SKW Alloys	Niagara Falls, New York (11,000 tpa)	0.3 km	0.5 km

2 NORWAY

Western World's second largest producer of silicon metal and its largest exporter. Production capacity estimated at 100,000 tpa although actual current production only about 70,000 tpa.

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Elkem a/s	Meraker, Smelterverk, Koffra (43,000 tpa)	0.1 km	0.3 km
Elkem a/s	Fiskaa Verk, Kristiansand (31,000 tpa)	0.3 km	0.3 km
Ila og Lilleby	Holla Smelterverk, Kyrksaeteroeta (21,000 tpa)	0.3 km	0.3 km
Tinfos Jerrverk	Notodden (12,000 tpa now shut down)	0.1 km	0.1 km

3 BRAZIL

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Comango Correa	Tucurui, Minas Gerais (32,000 tpa)	0.2 km	5.0 km
Cia Brasileira Carbureto de Calao (CBCC)	Santos Dumont, Minas Gerais (50,000 tpa silicon + ferrosilicon)	0.2 km	0.2 km
Ligas de Alumino SA (Liasa)	Pirapona Minas Gerais (40,000 tpa)	0.1 km	0.5 km

4 CANADA

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
SKW Canada	Becancour, Three Rivers, Quebec (25,000 tpa SiM + 25,000 tpa Ferrosilicon)	0.3 km	1.5 km

5 ITALY

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Indel SPa	Ospitale di Cadore (27,000 tpa)	0.0 km	0.1 km

6 SWEDEN

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Kema Nord Industrikemi AB	Ljungaverk, via Sunsvaal (24,000 km)	0.2 km	0.2 km

7 WEST GERMANY

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Vereinigte Aluminium - Werke AG	Rottwerk, Pocking (12,000 tpa)	0.2 km	0.2 km

8 PORTUGAL

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Milnorte - Metallurgia do Norte Sarl	Reguia (22,000 tpa - shutdown)	0.3 km	3.0 km
Cia Portugesa de Fornos Electricos Sarl	Canas de Senhorm, Melas (10,000 tpa)	0.1 km	0.1 km

9 AUSTRALIA

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Pioneer Silicon Industries	Electrona via Kingston, Tasmania (9,000 tpa)	0.3 km	0.3 km

10 SWITZERLAND

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Monte Forno Acciaicrie e Laminatoi SA	Lumino Switzerland (7,000 tpa)	0.1 km	0.2 km

11 EAST GERMANY

Company	Plant Location/ Annual Output	Distance from Nearest Housing	Distance from Nearest Group of 100 Residences or More
Ferrolog Werk Spremberg	East Germany (12,000 tpa)	0.1 km	1.0 km

12 YUGOSLAVIA

Elektrohemijska	Ruse, Yugoslavia (12,000 tpa)	0.1 km	0.2 km
Jugohrom	Yugoslavia (23,000 tpa)	0.2 km	0.2 km

Maunsell & Partners Pty Ltd
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OFFICES ALSO AT ADELAIDE, BRISBANE, CANBERRA, DARWIN, HOBART, MELBOURNE AND SYDNEY

24th December, 1987.

The Chairman,
Environmental Protection Authority,
BP House,
1 Mount Street,
PERTH. WA 6000

Attention Mr. J. Malcolm

Dear Sir,

BARRACK SILICON PROJECT PER

Since the publication of the Barrack Silicon Project PER questions have been raised in the media and by members of the public about the level of atmospheric emissions that could occur during direct venting from the silicon furnaces. In particular, concerns have been expressed that ground level concentrations of amorphous silica at Eaton, 1.5km from the proposed plant site at Picton, could exceed generally accepted standards.

The estimated maximum 1 hourly average ground level concentrations at 1.5km are:

- during scheduled events 0.29mg/m^3
- during unscheduled events 0.59mg/m^3

The source strengths adopted for direct venting calculations are:

- 2g/m^3 for scheduled events, and
- 3.5g/m^3 for unscheduled events

These are considerably less than the 15mg/m^3 used in the Wundowie ERMP, due to the availability of more recent specific data from operating overseas plants.

Barrack Silicon Pty. Ltd. has asked me to supply a further explanation in support of the conclusion presented in the PER that these levels are not expected to create an unacceptable nuisance to the public.

Ntd. No further needed
JM.

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015053

This conclusion is based firstly on a review of health literature and standards relating to amorphous silica. While there is some controversy amongst specialists on this subject, the majority consider that amorphous silica constitutes a nuisance rather than a health issue. The fact that the American Council of Government and Industrial Hygienists (ACGIH) has recently lowered the TLV for amorphous silica from $5mg/m^3$ to $10mg/m^3$ is evidence of this trend.

Secondly, the standard suggested in the PER for public nuisance purposes is highly conservative at one-thirtieth of the ACGIH TLV, ie

$$10/30mg/m^3 = 0.3mg/m^3$$

Various authorities including those in Tasmania adopt one-tenth of the TLV as a standard. On this basis a level up to $1mg/m^3$ could be considered acceptable. All predicted ground level concentrations at Eaton would be within this standard.

Further, the TLV is based on an assumption of continuous exposure for 8 hours of each working day. On this basis it is reasonable to relate the public health or nuisance standard to a period of exposure and to the occurrence of repetitive exposure events.

The maximum exposure time for an unscheduled event suggested in the data supplied from other plants is less than one hour. The maximum total annual exposure if all potential unscheduled events were to occur is an estimated 24 hours.

It would be necessary for any unscheduled venting to coincide with appropriate meteorological conditions for the $0.59mg/m^3$ level to occur at Eaton and it is highly unlikely that all potential unscheduled events would occur in any single year. Therefore, the occurrence of levels of amorphous silica dust above the target standard at Eaton is likely to be an occasional short-term occurrence only and repetitive, long term exposure is highly unlikely.

Given all of the above qualifications, we feel that the conclusion in the PER is appropriate. Should you have any requirement for further information and analyses we would appreciate early notification so that we can supply a response with minimal disruption to Barrack Silicon's project schedule.

Yours faithfully,
MAUNSELL & PARTNERS PTY. LTD.

DR. A. TINGAY
SENIOR ENVIRONMENTAL SCIENTIST

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

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Please address all correspondence to Executive Director, P.O. Box 104, COMO W.A. 6152

57

Your Ref:
Our Ref:
Enquiries: PNH:SP
Phone: 386 8811

The Director
ENVIRONMENTAL PROTECTION
AUTHORITY

Attention: Mr R A Field

SUBJECT: BARRACK SILICON PROJECT

Further to your letter of 27 November 1987 and the enclosed copy of the Public Environmental Report (PER), I enclose my Department's comments on the document.

Extracts from these comments may be used in the EPA assessment report, and the complete submission can be provided to the proponents for their information.

S R Shea

Syd Shea
EXECUTIVE DIRECTOR

18 January 1988

Att

015353

THE BARRACK SILICON PROJECT - PICTON

Comments by :

DEPARTMENT OF CONSERVATION AND
LAND MANAGEMENT
WESTERN AUSTRALIA

December 1987

APPENDIX D

ISSUES RAISED IN SUBMISSIONS FROM THE PUBLIC

APPENDIX D

ISSUES RAISED IN SUBMISSIONS FROM THE PUBLIC

SUMMARY OF ISSUE	NUMBER RAISING IT	REFERENCE IN REPORT
REVIEW PROCEDURE		
Why were concerns raised over ERMP not considered?	1	5.1
ZONING AND PLANNING ISSUES		
In or near a dust exclusion zone.	10	5.1.1.1
Industry classification doesn't match area zoning.	26	5.1.1.1
Bunbury Region Plan not quoted as a reference.	1	*
A "noxious" industry.	3	5.1.1.1
A larger buffer (5 km / 10-20 km) needed.	3	5.1.1.1
Many Eaton streets and the school not on Figure 4.1 of PER.	9	*
Agreement Act removes Dardanup Shire's rights.	1	*
Did SWDA buy land because political decision already made?	1	*
Wrong to breach BRP guidelines with the first development.	2	5.1.1.1
Change "comprehensively justified" only if no more noise/dust.	1	5.1.1.1
Siting just 9 km from seaside tourist resort is wrong.		*
Proposed new High School S of Eaton Dve, E of Hands Ave.	1	*
BRP p51 requirement re "large stacks" asks for 2 km buffer.	1	5.1.1.1
Project does not need port access.	1	5.1.1.1
Not a "general" industry according to Oregon contact.	1	5.1.1.1
Site needed for residential development.	3	*
Get it right first time, its expensive to move!	1	*
An environmental blot on the gateway to Bunbury.	1	*
METEOROLOGY		
Prevailing winds / availability of wind study.	23	5.1.5
Area subject to frequent inversions.	1	5.1.5
NOISE		
Details of Eaton noise measurement not given.	2	5.1.6.1
Noise study doesn't mention noise levels at Glen Iris.	1	5.1.6.1
Nightime noise from by-pass road too low for B1 category.	3	5.1.6.2
From what point are the noise contours measured?	1	5.1.6.3
Concern that noise will be annoying.	37	5.1.6.3
The noise study was inadequate.	1	5.1.6.3
Eaton residents hear noises from long distances away.	2	5.1.6.3
Swamps between plant and Glen Iris will reflect noise.	1	5.1.6.3
Noise will be distracting to school children.	2	5.1.6.3
Reduced noise level after 10 pm - children in bed before then.	1	5.1.6.3

SUMMARY OF ISSUE		NUMBER RAISING IT	REFERENCE IN REPORT
LIFESTYLE CONSIDERATIONS			
Property values will be reduced.		18	5.1.7
People are more important than siting costs.		3	5.1.7
Eaton is beautiful, don't spoil it or the lifestyle.		17	5.1.7
Undefined fears or apprehensions about the plant.		25	5.1.7
Chose Eaton not Australind to avoid SCM.		3	5.1.7
Too close.		41	5.1.7
Too close to school.		13	5.1.7
We were here first!		5	5.1.7
ALTERNATIVE SITES			
How is the project "too well advanced" to shift?		1	5.1.8
There are many other suitable sites.		7	5.1.8
Suggested sites:	the Picton "wedge"	2	5.1.8
	Worsley	6	5.1.8
	Kemerton	14	5.1.8
	Kwinana	1	5.1.8
	Collie	6	5.1.8
	near Wesfi	4	5.1.8
	Wundowie	8	5.1.8
	Wagerup	1	5.1.8
	along Picton-Muja power line	4	5.1.8
	south-east of rail loop	1	5.1.8
Residents would think SE of rail loop is still too close.		1	5.1.8
SE of loop - the organic sediments if any can be easily removed.		1	5.1.8
Trucking ore from rail to site, so no need to be near rail.		2	5.1.8
Most blocks in Figure 6.1 are closer to Kemerton than Picton.		2	5.1.8
Can establish 20-30 km from town as Worsley have.		1	5.1.8
CONSTRUCTION OF THE PLANT			
Little biological information about site in PER.		1	5.2.1
Why was a preliminary flora assessment acceptable?		1	5.2.1
Excessive noise is likely during construction.		1	5.2.2
COMMISSIONING OF THE PLANT			
Excessive noise is likely during commissioning.		1	5.3.1
Disagree with not implementing full noise contol at once.		6	5.3.1
Likely to be problems with dust during commissioning.		4	5.3.2
MINING OPERATIONS			
Concern over regeneration of *Regelia megacephala*.		1	5.4.4
No detail of ore transport from Picton railhead to plantsite.		1	5.4.5

SUMMARY OF ISSUE	NUMBER RAISING IT	REFERENCE IN REPORT
WOOD GATHERING OPERATIONS		
Alternative uses for the wood		
What provisions will be made to guarantee domestic firewood?	6	5.5.1
Cottage industry using dead jarrah for fine furniture will suffer.	2	5.5.1
Impact on forest management		
-Supply capacity		
CALM Region Mgmt Plan doesn't specifically cover this project.	1	5.5.2.1
Doubt that the forest can supply that much firewood.	1 2	5.5.2.1
What about the long-term wood supply?	5	5.5.2.1
Regenerative capacity of some forest blocks doubted.	1	5.5.2.1
Won't most dead timber have termites?	1	5.5.2.1
-Disease		
What procedures will be used to prevent spread of dieback?	6	5.5.2.2
Some dieback-affected blocks not shown as such in PER map.	1	5.5.2.2
What control to stop dieback spread from stockpile drainage?	1	5.5.2.2
-Other impacts on the forest		
What effect will the project have on the nutrient cycle?	3	5.5.2.3
Project will change forest into a silvicultural plantation.	1	5.5.2.3
Unless Barrack take mostly (75%) green, little benefit for forest.	1	5.5.2.3
Impact on other forest uses		
-Fauna habitats		
Concern over lack of knowledge of effects on arboreal species.	6	5.5.3.1
The postgraduate research should be done before startup.	1	5.5.3.1
The use of hollows by fauna needs to be monitored.	1	5.5.3.1
-Tourism		
What about the tourist potential of the forest?	1	5.5.3.2
Traffic		
What about noise from log trucks delivering wood?	1	5.5.4
Other issues		
Why can't they use off-cuts from the jarrah mills?	1	5.5.5
What are Barrack paying for the wood?	1	*
With such cheap wood, they ought to fund more forest research.	1	*
CALM's priority is wood production. They shouldn't be responsible for environmental consequences of the project.	1	5.5.5

SUMMARY OF ISSUE	NUMBER RAISING IT	REFERENCE IN REPORT
CHARCOAL PRODUCTION		
Alternative sources of carbon		
What analysis was there of alternative reductants?	3	5.6.1
Noise		
Sawing and feeding logs will create a lot of noise.	2	5.6.2
Concern that noise will be annoying.	37	5.6.2
Stormwater		
Concern over discharge of water into Preston River.	5	5.6.3
What alternatives are there to river discharge of water?	2	5.6.3
Why not recycle the water if it is clean enough to discharge?	1	5.6.3
Sedimentation ponds should be designed for a 100 year flood event.	1	5.6.3
What are the details of the drainage system?	1	5.6.3
What monitoring of water is proposed?	1	5.6.3
Oil and grease traps should be installed.	1	5.6.3
Emissions and dust		
Concern over downwind formation of oxides of nitrogen.	2	5.6.5
Concern over direct venting of charcoal retorts.	1	5.6.5
Two different heights for charcoal retorts.	2	5.6.5
Concern over likely unpleasant odours.	1	5.6.5
What evidence that the incinerator will oxidise all organics and CO?	1	5.6.5
Do data on top of PER p28 relate to jarrah or some other wood?	1	5.6.5
Control of dust from cartage and stockpiling of raw materials.	2	5.6.6
Concern over effect of charcoal dust on quality of rainwater collected from roof or of swimming pool water.	6	5.6.6
SILICON PRODUCTION		
Health implications of silica fume		
Concern that medical authorities differ over toxicity of fume (including references to Wnekowski report).	24	5.7.1
Concern that children are more at risk.	10	5.7.1
Concern that health conditions will be made worse:-		
Asthma	9	5.7.1
Cystic fibrosis	3	5.7.1
Emphysema	1	5.7.1
Allergies/Hay fever	3	5.7.1
Problems of chest, nose & throat/bronchitis	3	5.7.1

SUMMARY OF ISSUE	NUMBER RAISING IT	REFERENCE IN REPORT
Concern over effect of fume on quality of rainwater collected from roof or of swimming pool water.	6	5.7.1
Report "I can't guarantee people's health..." Spratt	19	5.7.1
Dust may be found harmful in 20 years' time.	3	5.7.1
What is the impact of the dust on chickens?	1	5.7.1
The TLV in the PER is for precipitate or gel, not amorphous silica.	1	5.7.1
Dr Gross recommends a TLV of 50ug/m3(100 times nuisance level)	1	5.7.1
The PER has no information on particle size.	1	5.7.1
All workers should be informed of the health risk.	1	5.7.1
Emissions of silica fume and operation of the baghouse		
Doubt that dust emissions will be as low as claimed.	22	5.7.2
Relying on achievement of manufacturer's claims 100%.	1	5.7.2
Change to another reductant - site would be less suitable.	4	5.7.2
Won't only 1 baghouse mean more direct venting?	3	5.7.2
Electrona had 200 hours direct venting during commissioning, and another 200 hours since then.	4	5.7.2
What about the ozone produced by electric arcs?	2	5.7.2
The Oregon plant does not direct vent.	1	5.7.2
Why not have backup generators for the baghouse?	1	5.7.2
Direct venting should be monitored. Who by?	3	5.7 2
If there's too much venting will the plant be forced to close?	2	5.7.2
Discussion of organic emissions from furnace is inconclusive.	2	5.7.2
Will the use of green jarrah cips generate organic emissions?	1	5.7.2
The lower melt temperature may lead to impregnation of bags with pyroligneous vapors, reducing efficiency.	1	5.7.2
Will baghouse capture very fine (<1um) particles?	1	5.7.2
To say direct venting will be "timed to avoid.." is too vague.	2	5.7.2
Transport and handling of fume		
What are the plans for fume disposal if it cannot be sold?	1	5.7.3
Noise		
There have been on-going noise problems at Electrona.	2	5.7.4
Bigger than Electrona, so more noise is likely.	1	5.7.4
The shot gun should be used during the day time only.	2	5.7.4
Water supply, use and disposal		
Was WAWA water licence issued a fortnight after Bunbury Water Board recommended a moratorium?	2	5.7.5
The water source should be monitored for quantity and salinity.	1	5.7.5

SUMMARY OF ISSUE	NUMBER RAISING IT	REFERENCE IN REPORT
Other considerations		
What extra noise/dust from the expansion to 29,000 t?	1	5.7.6
Why not use Bunbury port?	1	5.7.6
Eaton has frequent electrical interruptions.	1	5.7.6
Is the price paid for electricity subsidised?	3	5.7.6
What will be the electromagnetic effects on radio, TV, industry?	3	5.7.6
Control of dust from cartage and stockpiling of raw materials.	2	5.6.6
Is separation between furnace and watertable OK (it was a problem for the Aluminium smelter at Kemerton).	1	5.7.6

* These issues were not discussed in this assessment report because they were not considered environmental issues. Some of them, for example, are planning issues.

APPENDIX E

RESPONSES FROM GOVERNMENT AGENGIES

CONSERVATION AND LAND MANAGEMENT
(submission and replies to questions)

HEALTH
(submission)

LESCHENAULT INLET MANAGEMENT AUTHORITY
(list of questions submitted by EPA to Barrack)

MAIN ROADS
(submission)

MINES
(submission)

OCCUPATIONAL HEALTH, SAFETY AND WELFARE
(submission and supplementary submission)

STATE PLANNING COMMISSION
(submission)

WESTRAIL
(submission)

SUMMARY

The Department of Conservation and Land Management has carried out a review of the PUBLIC ENVIRONMENTAL REPORT (P.E.R) for the Barrack Silicon Project to be located at Picton, near Bunbury, WA.

The review has concentrated mainly on aspects which relate to the provision of jarrah timber of firewood quality for the production of charcoal.

The P.E.R. generally conforms with the detailed Environmental Review and Management Programme (ERMP) which was prepared for the former owners of the project, Agnew Clough in January 1987 except that the whole process will now be carried out at Picton (in lieu of Coolup and Wundowie) and the firewood resource will now be obtained from the Central Forest Region.

The resource available to the proponent has been checked, and the Department is satisfied there is no difficulty with the level of resource required, nor will there be any adverse effects on the sustained yield of the forest.

This review describes the Department's plans for provision of the firewood resource from three sources viz:

* integrated logging for the sawmill industry;
* clearing forest for the new Harris River Dam;
* salvage logging in severely dieback affected forest, mainly near the western edge of the Darling escarpment.

CALM has adequate existing field control procedures to ensure compliance with all environmental protection requirements.

The environmental impacts of the provision of the firewood resource have been evaluated and no serious adverse impacts have been identified.

The project has the potential to bring important benefits for management of the jarrah forest, improving the efficiency of timber utilisation and thus extending the old growth resource, improving the efficiency of regeneration and improving forest productivity.

INTRODUCTION

This review is in response to the invitation from the Environmental Protection Authority (EPA) to comment on the Barrack Silicon P.E.R.

The proponent has estimated the timber resources available for the project and has assessed the environmental impact of supplying the timber. The appraisal was necessarily incomplete, since the administration of the procurement of the firewood resource and of the forest from which it comes, are the responsibility of the Department of Conservation and Land Management (CALM). This review will elaborate on certain aspects of the Project to assist the EPA in making its recommendations to Government.

OVERALL FOREST MANAGEMENT CONSIDERATIONS

Management plans for all CALM land are a requirement of the CALM Act. These plans set out the issues in each area and describe how CALM proposes to address them, together with management guidelines and policies currently in use. Accountability for field performance is the responsibility of the Operations Directorate of the Department.

The area of forest from which timber supplies will be drawn for the proposed charcoal production facility is covered by the Central Forest Region Plan and by the State Timber supply strategy. These documents were approved by the Minister for Conservation and Land Management on 18 December 1987.

A feature of the jarrah forest is the large resource of timber which is below sawlog specification and which presents serious problems for forest management. Availability of a market for this poor quality material would have the effect of greatly facilitating efficient regeneration of cut over forest, of increasing the efficiency of utilisation of timber harvested and of increasing the growth rate of the whole forest. Utilisation of this previously unsaleable resource also has a positive economic advantage to the State. It is important to note that the costs to the proponent of delivery of firewood logs to the charcoal plant will include all "in-forest" costs of administration of the operation, and a charge to cover their share of road construction costs. Some additional staff will be required to ensure that firewood logs of the required specification are provided to the plant.

The CALM Act also sets out a clear objective for the forest as a whole to be managed on a sustained yield basis. This is reflected in the forest management guidelines which state that the aim of management is to

> "adjust the cut from the native forest progressively to a level consistent with the growth of the forest ....".

The sustainability of the timber yield from the forest is further considered under Resources, below, but sustainability can also be considered from the viewpoint of maintaining the jarrah forest ecosystem itself. This has been ensured in two ways; 34% of the forest is in secure reserves, which will remain uncut and intensive, long-term research is proceeding to ensure the forests continued productivity.

There are, of course, some changes in the jarrah forest ecosystem clearly in progress where dieback disease has had a severe effect, and the bauxite mining industry is the cause of the conversion of about 350 ha a year to other eucalypt species. Otherwise, there is no evidence to suggest any past management actions have had a long-term adverse effect on the ecosystem as a whole.

FIREWOOD RESOURCES

CALM carries out periodic broad scale Resource Level Inventories (RLI) over the jarrah forest, recording the volume of sawlogs, firewood and regrowth by species. Although the inventory is based on a sample of only about 0.6% of the area, it is statistically valid over the forest as a whole.

In addition to the RLI, a Management Level Inventory (MLI) is carried out on individual logging coupes to provide more precise data for the rolling five year logging plans. These rolling plans are updated annually.

The firewood resource data in the P.E.R. combine both MLI and RLI figures to develop a summary. It has been of concern to CALM that the RLI data are over 10 years old, and did not assess the firewood resource according to the specification of the Silicon project. However, re-evaluation and field inspections with the proponent have confirmed there is adequate resource of firewood available for the life of the project in the Harvey, Collie, Busselton, Nannup and Kirup districts. The principal difference in firewood availability caused by shifting the focus of the project to Picton, is that dry the firewood component (trees already dead) is more scattered and has a longer haulage factor than for the Coolup site.

The Public Environmental Report states (p.35) that over two thirds of the resource will come from the Harvey District and one third from Collie District. While in some years of the operation this may prove to be correct, in order to make maximum use of available green and dry firewood, especially in the north western part of Kirup District, CALM reserves the right to draw on all forest areas within the same general radius of Picton including the Donnybrook Sunkland and Kirup District.

The old, unmarketable and often quite large trees which can be removed as green firewood have prevented efficient regeneration and achievement of maximum potential increment in selection cut forest.

Their removal would be a major advance in silviculture of the jarrah forest. For the first time, complete regeneration of cutover forest will be possible. (It should also be noted that removal of dead (dry) trees only has virtually no beneficial effect on the forest or its regeneration).

It is CALM's experience that the availability of a residue market enables a logging contractor to fell and evaluate virtually all trees nominated for removal. About 10% of those trees will prove to be acceptable as sawlogs, so, in this way, the Silicon Project would have an additional beneficial effect on utilisation of the forest resource. It is important to note that the availability of a firewood market does not imply that all dead or defective trees will be felled. A significant proportion of dead trees and trees with hollow butts cannot be felled for safety reasons. There is also a continuing loss of trees in the jarrah forest due to natural causes, and dieback disease.

Page 39 of the P.E.R. stresses the Company's reliance on dry timber being supplied for the first 5 years. While this is obviously desirable from the proponents viewpoint, as timber must be dry to optimise charcoal production, it is not in the best interests of overall forest management for dry timber only, to be produced. It has always been CALM's intention that supply of timber for the charcoal production facility would be integrated with other logging operations in order to achieve operational efficiency and economy, as well as silvicultural benefit. This means that existing logging operations, in addition to supplying sawlogs, poles, mining timber etc, will now harvest dead trees and live, previously unmarketable trees, from the same logging coupes. The proportion of dry and green firewood to be supplied in any period will be included in detailed logging plans prepared by the Department on an annual basis, in consultation with the Company.

As the resource obtainable from these integrated operations will be only about 50% of dry wood, the project will be supplemented by a separate operation confined to areas of forest severely affected by dieback, and where the majority of trees would be dead or dying. This operation will enable valuable rehabilitation work to be carried out in conjunction with or soon after logging.

The requirements for 24 000 tonnes per year of green firewood (P.E.R. page 37) for direct feed to the Silicon furnaces could be obtained from thinning of high quality regrowth jarrah at Harvey or Collie. However, initially the proponent is negotiating with jarrah sawmillls for woodchips produced from sawmill waste. Should this prove to be unsatisfactory a regrowth thinning operation will be established.

A further source of both green and dry firewood is the clearing of the site for the Harris River Dam near Collie, which is due to commence in March 1988. In addition the removal of dead and stag-headed trees from the boundaries of pine plantations in the Donnybrook Sunklands can be recommenced to produce dry wood while also improving the fire protection for these plantations.

IMPACT OF THE SILICON PROJECT ON THE FOREST

The proposed Silicon Project has a number of potential impacts on the forest in such areas as spread of dieback disease, export of nutrient capital, salinity of streams, increased soil erosion and adverse effect on flora, fauna and the ecology of the forest in generally. These will be considered in turn.

a) Dieback Disease

The planning and performance of all forest operations in the jarrah forest are dominated by the requirements for the prevention of further infection due to the soil fungus Phytophthora cinnamomi. The requirements for protection of forest from the disease, and for handling areas already infected are spelt out in greater detail in field operations manuals, and the Department's policy statements.

The harvesting of firewood for the Project would be subject to the same stringent controls as are applied to all other timber harvesting activities. It has been made quite clear to the proponent that they will receive no concessions at all in this respect.

On this basis the Project will not result in an increased potential to spread the disease.

b) Export of Nutrients from the Forest

A possible long-term loss in forest productivity due to the export of the nutrients contained in the wood, is often raised as an argument against intensive forest management. The argument has stimulated a great deal of research in Australia in the last 10 to 15 years, some of it in the jarrah forest.

Research published by Hingston et al from CSIRO gives estimates of the available nutrient pool on typical jarrah forest sites and confirms that jarrah grows in extremely infertile sites. These facts are confirmed by the low nutrient element content of the timber and is the very reason why jarrah charcoal is attractive for the production of high grade Silicon - it contains very low levels of chemical "impurities".

The Silicon project will therefore not have a significant impact on the nutrient capital of the forests.

c) Stream Salinity

The environment of the jarrah forest as a whole, is an area of widespread concern with respect to stream salinity. Concern over the possible adverse effects of bauxite mining led to the initiation in the mid 1970's of a large amount of research on land use and salinity in this area.

There is now a very complete body of knowledge on regional trends in soil and stream salinity, and a great deal is known about hydrological processes in the region. Using this knowledge we are now able to predict with reasonable precision the consequences of any significant change in land use. The removal of dead standing trees or logs on the forest floor can have no possible influence on stream salinity. The removal of live trees could have an adverse effect only if all trees were removed, without regeneration, over large areas of forest in the eastern zone (less than 1 100 mm rainfall). This could not happen, since the prime silvicultural objective of the removal of residue logs is to improve the quality of regeneration and to improve forest health and vigour. There are also forest management guidelines for the eastern zone of the forest agreed upon with the Western Australian Water Authority, which ensure that the amount of forest cover left after a logging operation does not fall to a level which would disturb the hydrological balance.

Logging coupes are also widely dispersed over the forest. Normally only a small proportion of any catchment area is affected each year.

d) Soil Erosion

Soil erosion control is covered in forest harvesting operations by prescriptions in operational manuals, when the logging contractor is obliged to install appropriate structures to contain erosion. Of more concern to CALM is

the possibility of soil damage through continuation of logging operations in excessively wet conditions. This is approached in two ways : ceasing harvest operations, particularly log skidding into the bush landings, and by requiring the contractor to carry out rehabilitation. The manuals also specify procedures to prevent entry of sediment into streams.

Logging for the Silicon Project will be required to conform to all these specifications, consequently no additional erosion or stream sedimentation will result.

e) Impact on Flora and Fauna

The proposed increase in the harvest from the forest for the Silicon Project is unlikely to have any observable effect on the flora of the region. The increased intensity of logging does offer the potential for more soil compaction, which could adversely effect some species of flora. However, the gravelly and generally coarse textured soils which predominate in the jarrah forest are less susceptible to compaction than most soil types.

The removal of more jarrah trees is also not expected to have a serious adverse effect on the quantity of jarrah nectar produced and hence an effect on the beekeeping industry. The trees removed will be dead, in poor health due to over-maturity, or come from dense regrowth stands. The more vigorous forest which will result from improved silvicultural treatment is likely to produce more nectar.

The effect of the project on fauna is more complex.

There will undoubtedly be a decline in the availability of nest sites for hole nesting fauna and of cover for fauna requiring logs on the ground. However, as noted previously, not all trees with hollow butts can be felled. Further, a proportion of the logs on the ground, mainly the older ones, will be too rotten or too heavily attacked by termites, to be suitable for firewood. It has been estimated that an amount of deadwood equivalent to that removed, will remain on the forest floor.

The jarrah forest - because of the incidence of wildfire and jarrah dieback - has large numbers of dead and defective trees. It also has a large quantity of material on the ground - logs, crowns and stumps remaining from past logging operations. This means that the number of nest holes and log habitats is greatly in excess of that which would have been present in the natural forest. This would ensure that the project would not have a significant impact on fauna.

Large fauna will not be affected by the project as they have coped well with a much larger timber industry in the past than exists today. More quantitative data are available from recent research on bird habitats in the jarrah forest. Abbott and van Heurck studied the bird population in jarrah and yarri (E. patens) forest, unlogged, and where half the trees had been removed. They found the number of bird species and total number of birds were similar in both areas.

The proponent has agreed (p.41) to fund a post graduate research project to study the impact of firewood log removals on the niches available as nesting hollows for birds and small mammals. CALM accepts this proposal but would expect to be the prime agent in design and control of the study.

CONCLUSION

The Department of Conservation and Land Management has carefully reviewed all aspects of the proposal to harvest jarrah for the production of charcoal for the Barrack Silicon Project. It is satisfied that there will be no difficulty in availability of the timber resource, and that continued dialogue with the proponent is resolving the problems of dry wood/green wood, firewood specification and sources of supply.

No significant adverse environmental impacts of the Project are foreseen in respect of its impacts on the forest.

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Dr Syd Shea,
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Enquiries Jim Malcolm

BARRACK SILICON PROJECT

In the analysis of submissions received during the public review of the above project the Authority has encountered a number of questions which relate specifically to the planning and management of the wood supply for the project.

As you are no doubt aware, the Public Environmental Report for the proposal states that the environmental management of the wood supply for the project is the responsibility of the Department of Conservation and Land Management.

I would be grateful, therefore, if you could assist the Authority in the assessment of the project by responding to the questions which are listed on the attached sheets.

R A Field
DIRECTOR
EVALUATION DIVISION

10 February 1988

BARRACK SILICON PROJECT

QUESTIONS RELATED TO WOOD SUPPLY

1. Several submissions noted that domestic firewood use was increasing with the popularity of wood-burning stoves for heating. They claimed that CALM had underestimated the likely future need for domestic firewood. Could the Department briefly indicate how its estimation was made and how it proposes to cater for domestic firewood requirements, both through contractors and gathering by the general public?

2. Some noted that dead jarrah had a special value to the cottage industry producing fine furniture, and felt that the demand pressure would threaten this developing industry. Would the Department comment on this aspect of the demand for dead jarrah?

3. One submission noted that as the proponents were getting their wood so cheaply, they should be prepared to fund more research on the monitoring and rehabilitation of the forest resource. What is the Department's view?

4. One submission claimed that it would be irresponsible to allow the project to go ahead with an acknowledged lack of information on the likely effect of the project on habitats for arboreal species. In view of the uncertainty, what management procedures is the Department planning to protect and monitor these species?

5. Several submissions were concerned about dieback. One asked "can dieback be successfully contained" in this project; and another was concerned about the possibility of spreading dieback from the stormwater drainage of the log stockpile on the plant site. Would the Department comment on these issues?

6. One submission asked "surely most dead timber will have termite activity" (and therefore be unacceptable)? In the Department's experience what proportion of deadwood is termite affected?

7. One submission claimed that the regenerative capacity of Collie forest blocks Bristol, Sherwood, Western and Centaur should be seriously questioned. Does the Department agree? If this were the case, what impact would it have on the Department's plans for wood supply for the project?

8. The same submission noted that the map on p36 of the PER does not show Davis, Arcadia, Yabberup, Sherwood and Bristol blocks as dieback-affected while the map on p9 of the Central Region Management Plan does show them as affected. Are these blocks affected? Do the Department's supply plans take the state of these blocks into account?

9. One submission claimed that the value of the project for improvement of the forest and for improving timber utilisation efficiency is directly related to the quantity of *green* residue removed. It claimed that removal of dead residue does nothing to improve the condition of the growing stock in the forest and therefore that if Barrack was not prepared to accept a high proportion (say 75%) of green timber the project would have, on balance, little benefit for the forest. Are these claims correct? It is understood that the proportion of green wood supplied is likely to vary over the life of the project, but what proportions does the Department expect to supply?

10. One submission from the Council of one of the Shires from which wood is to be taken expressed a requirement for an agreement on roads so that the cost of extra maintenance was not borne by the Council. The Department's submission refers (p 2, para 4) to "the cost to the proponent of delivery of firewood logs to the charcoal plant" including "a charge to cover their share of road construction costs". Does this charge include an allowance for additional maintenance on Shire roads, and if so how will this be paid to the Shires?

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The Director
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ENVIRONMENTAL PROTECTION AUTHORITY

ATTENTION: Mr Jim Malcolm

BARRACK SILICON PROJECT

In reply to your letter of 10 February 1988, the following information is provided in response to the questions you asked.

1 **Use of domestic firewood**

CALM obtains monthly figures of licences issued to commercial firewood operators and also returns from sawmills advising how much firewood was sold from mill residues. As part of the Timber Strategy, discussions were held with the Solid Fuel Merchants Association and other firewood cutters and estimates were made as a result of these discussions.

Domestic firewood requirements for the metropolitan area will be met from forest areas north of the Murray River. Firewood resource from this area has not been counted in assessing the resource available for the silicon project.

Designated public firewood areas have been set aside and are publicised. In the Bunbury/Harvey area specific forest blocks have been set aside for firewood and will not be made available to the silicon project.

2 **Cottage industry using dead jarrah**

Licences issued by the department to date are for volumes in the tens of cubic metres.

While I have not heard of a proposal to make dead jarrah into fine furniture, there would be ample scope to produce large quantities of wood from areas not to be covered by the proposed project.

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3 Funding for research

The proponents are paying market value for their wood, the same as any other user of similar wood. It is anticipated that dieback areas covered by the project will be rehabilitated in conjunction with the logging process. The company has agreed to fund research work by a post-graduate student to study the effect of firewood operations on the availability of nesting hollows remaining in the forest.

4 Habitats for arboreal species

The department funds a huge research effort to study fauna and flora in the forest. This is an ongoing program and includes detailed studies into the habitats of fauna. Assessments have indicated that there is at least double the volume of dead jarrah below the firewood specification which will remain in the bush. This material will provide more than adequate nesting areas.

5 Effect of dieback

The timber for the project will be obtained as part of an integrated logging operation to provide sawlogs for mills in the area. Therefore, firewood operations will be subject to exactly the same stringent dieback hygiene controls and limitations as any other logging project. The department's dieback policy entitled "Dieback 82", a copy of which your authority already has, outlines the method to be followed.

It is understood that drainage from the log stockpile area is the subject of a detailed plan. Surface water from the stockpile area will lead straight into the river system nearby and into the ocean and will not be allowed to disperse into adjacent areas.

6 Effect of termites

Termites are not acceptable in timber to be supplied. Assessments to confirm that there is ample resource available to the project have not counted termite affected timber.

7 Regenerative capacity

No. Areas harvested to provide wood for the project will actually have their regenerative potential increased because large old previously unmerchantable trees will be now be able to be removed allowing space for new trees to grow.

Your second question is hypothetical and will not occur.

8 Dieback affected areas

Dieback does not affect a whole forest block, so it is an over simplification to say whether a block is affected or not affected by dieback. It is unlikely that any forest block in the western part of the jarrah forest is totally free from dieback. The department has figures for all the resource in each of the Collie, Harvey and Kirup districts.

9 Proportion of green to dead resource

It is true that the sale of green residue will have a greater benefit to general forest management than purely harvesting dead residue. Assessments have shown that there are approximately equal amounts of dead and green firewood available. The department is at present negotiating with the company regarding the year by year proportion of dead and green firewood. Over the life of the project, green and dead firewood will be supplied in the same proportion as it occurs in the bush.

10 Maintenance of Shire roads

The roading charge, to be paid by the company, that the department is referring to in its statement is to cover the construction and maintenance of forest roads only. I am mindful of the Shire Council's concern and have instituted discussions with the Main Roads Department regarding extra finance to be provided for any additional road maintenance of Shire roads. It is difficult to reach any finality in this matter when there has not yet been any decision on whether the project is going ahead, or if so, on what site and using which routes.

Please do not hesitate to contact me again if you have any further points requiring clarification.

Syd Shea
EXECUTIVE DIRECTOR

25 February 1988

DJK:DJ

QUESTIONS RELATING TO HEALTH ASPECTS OF "SILICA DUST" RAISED IN SUBMISSIONS ON THE PROPOSED PICTON SILICON SMELTER

1. The company has described silica dust as a nuisance dust while Dr Wnekowski in her review paper concludes that it should be regarded in the same way as crystobalite, the most toxic form of silica. Who is right?

2. What exposure level limits do you recommend for silica dust for the general public, both as 24 hour mean and annual arithmetic mean?

3. Does the higher level of activity of children and related mouth breathing significantly increase their health risk?

4. What significance does silica dust have for sufferers of asthma, hayfever, cystic fibrosis and emphysema? At what dust concentrations is this significance evidenced?

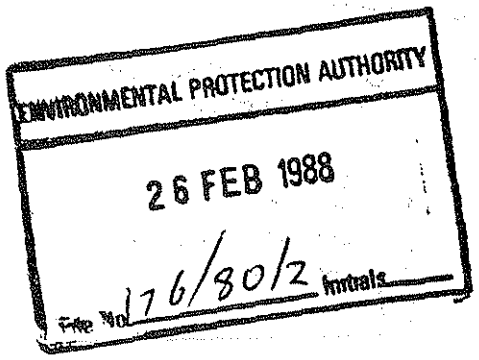
5. Some submissions expressed concern over the dust contaminating the rainwater they collect from their roofs for domestic water supplies. Are there any health dangers from ingesting silica dust?

NOTE : Silica dust in the context means the silica dust given off from the proposed furnaces. The evidence suggests that it is composed mainly of fused amorphous silica, though some sources suggest that it may contain small amounts of crystalline silica.

Health Department of Western Australia

Western Australia

Your ref
Our ref 8025/88 PPS:dr
Enquiries Dr P Psaila-Savona



Chairman
ENVIRONMENTAL PROTECTION AUTHORITY

BARRACK SILICON SMELTER PROPOSAL - PICTON

I refer to the letters sent by your Dr R A Field, Director Evaluation Division, to Dr P Psaila-Savona of this Department.

The Public Environmental Report and the related papers sent by you have been studied and it is now possible to make comments in regard to the public health implications of the emission of silica dust from the proposed smelter.

The initial PER discussed the health implications of the emission of amorphous silica but failed to discuss in any detail the possibility of change from amorphous silica to the cryptocrystalline type which could produce an uncommon form of silicosis.

The health implications were rebutted quite substantially by Dr Wnekowski and in her well researched paper made some very valid observations which required a further review of the health issues involved in this case.

This further review has been provided in the paper prepared by Maunsell and Partners "Public Health Implications of Potential Amorphous Silica Emissions From the Proposed Barrack Silicon Plant at Picton". This paper is excellent and has taken into account additional information which became available after the initial PER was prepared.

This paper admits to a change in position.

It is not necessary to go into great detail to critically review this paper since in most respects it tends to agree with the arguments made by Dr Wnekowski.

As you have requested advice from the Commissioner, Department of Occupational Health, Safety and Welfare regarding the occupational health issues it would be imprudent for this Department to make any comment regarding the occupational health implications and therefore our comments are mainly restricted to public health matters.

60 Beaufort St Perth WA 6000 Tel (09) 328 0241 Telex AA 93111 Telegrams WAHEALTH
Letters PO Box 8172 Stirling St Perth 6000

As stated in all the papers submitted and additional review of the literature available to this Department, there are no public health standards for silica fumes. Consideration should therefore be given to the nature of the fume and the risk to public health from the emissions of such fumes. It is well accepted that amorphous silica by itself does not seem to give rise to public health concerns but under certain circumstances, in particular high temperature incineration, it can transform to cristobalite and then a potential silicosis hazard may occur.

The risk of this happening given the kind of emissions described in the PER has been well assessed in the Maunsell and Partners Report when operations both under standard and non-standard situations have been described. The assessment under a "worst possible case" condition appears satisfactory.

In this regard and with this background, it is appropriate to use the draft occupational health standards for silica fume of $2mg/m^3$ to attempt to derive public health standards. An annual average of $0.07\ mg/m^3$ and a 24 hour average of $0.10\ mg/m^3$ seem quite appropriate and do not seem substantially different to the WHO guidelines at present proposed for total suspended particles.

If the plant is capable of operating within these standards, it is unlikely that there will be any public health concerns.

You have posed additional specific questions in the attachment to your letter some of which I believe have already been answered. This additional information is provided:

1. Silica dust is not a nuisance dust and has never been described as such. Amorphous silica may be classified as a nuisance dust but under high temperature conditions may be transformed to a toxic dust.

2. This has been discussed above.

3. Yes - but it is believed that the levels recommended will protect all but the most sensitive of individuals.

4. As in 3 above.

5. There is no indication that the ingestion of silica dust poses any public health risk.

I trust that the above information is useful. Please do not hesitate to contact this Department if further clarification is required.

W. D. Roberts

W D Roberts
COMMISSIONER OF HEALTH

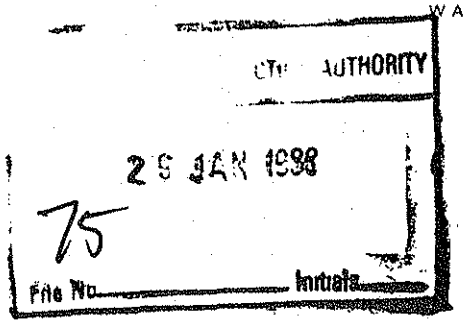
18 February 1988

LESCHENAULT INLET MANAGEMENT AUTHORITY

Your Ref.

In reply please quote 40.4.1
VKLH

P O BOX 261
BUNBURY
W A 6230



ATTENTION: MR. J. MALCOLM

Chairman.
EPA,
Mount Street,
PERTH, W.A. 6000

Dear Sir,

RE: BARRACK SILICON PROJECT, BUNBURY

The Leschenault Inlet Management Authority has considered the Barrack Silicon Project PER and finds that there is insufficient and unclear information on waste water disposal and its constituents to allow adequate assessment of the impact on the Preston River. The Authority is particularly concerned at the possible discharge of corrosion inhibitors (including chromates) and the impact of this on the Preston River.

The Authority submits the following recommendations as part of its assessment of the PER.

1. The Authority requires information on the following aspects of waste water management for the site:

   - Groundwater quantities to be used. The volumes quoted in the PER do not relate to the groundwater licence issued by the Water Authority of W.A. (see attachment 1).
   - The quantity of water to be discharged to the Preston River.
   - The likely constituents in the discharge waters.
   - The proposed treatment of waste waters prior to discharge.
   - The drainage system to be used to allow discharge to the Preston River.
   - Details of the origin of all waste water and stormwater from the site.
   - Details of alternative effluent treatment methods (e.g. recycling) that have been considered.

.....2

015536

- The proposed monitoring strategy for waste water discharge.

- Details of possible sources of pollution from within the site (e.g. nutrients from ash, tanins causing high BOD from wood).

2. As the site is proposed in the new Industrial Estate it is requested that stormwater be retained on site as far as possible and that its implementation and management be consistent with that of the Estate as a whole.

3. That an oil and grease trap be installed on any stormwater outlet to prevent pollution of the Preston River (see Assessment Report - Attachment 2).

The Authority does not consider that the PER was suitable for public release, particularly as the issue of waste water treatment and disposal was not adequately addressed. Therefore, the Leschenault Inlet Management Authority does not consider that a determination can be made until the information requested becomes available.

Yours faithfully,

Don Eckersley.

SIR DONALD ECKERSLEY
CHAIRMAN

20th January, 1988.

Encs

MAIN ROADS DEPARTMENT

WATERLOO CRESCENT, EAST PERTH, WESTERN AUSTRALIA.
GPO Box X2255 PERTH WA 6001 Phone 323 4111 Fax 323 4430 Telex AA 92894

Enquiries Mr Wheeler on 323 4130

Our Ref 72/312-45

Your Ref 176/80

Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Attention: Mr J Malcolm

PICTON SILICON PER

Thank you for the opportunity to comment on the above. Your correspondence of November 27 1987 refers.

The following comments are submitted for your consideration:

The log haulage trucks are proposed to be 20 metres long with a gross weight of 70 tonnes. These vehicles will be overlength and overweight and will require a permit from the Commissioner of Main Road authorising the operation. Details of the proposed cartage routes will be required for assessment of the suitability for overload and overlength carting.

The type of vehicle proposed for cartage of quartz from the rail yard at Picton to the plant site is not stated but it is assumed that this will be a regulation vehicle otherwise a permit will also be required for this operation.

The entrance to the plant site from Armadale-Bunbury Road will require approval by this Department and the consulting engineers, GHD Dwyer, have been in contact with our Bunbury office in this regard. Provided that the intersection treatment makes satisfactory allowance for turning vehicles then the proposed silicon project will have little impact on the main road system.

You may use these comments at your discretion.

J G O Hackett
SENIOR ENGINEER PLANNING

February 3 1988

PL-1644

015750

DEPARTMENT OF MINES
MINERAL HOUSE · 66 ADELAIDE TERRACE · PERTH · WESTERN AUSTRALIA · 6000

The Chairman
Environmental Protection Authority
BP House
1 Mount Street
PERTH WA 6000

TELEPHONE (09) 222 3333
TELEGRAMS "WAMINES" PERTH
TELEX AA 95791 MINEWA
FACSIMILE (09) 325 1029

Your Ref:
Our Ref: TJR:AH 685/87
Enquiries to: Mr Robinson
Telephone: 222 3543

BARRACK SILICON PROJECT - PER

The PER has been reviewed by this Department. The following comments are provided for your assistance.

The Director of the Geological Survey has indicated that the document comprehensively covers the principal environmental management and monitoring aspects of the proposed Moora minesite and Picton process site. Specifically:

- Adequate supplies of quartzite and groundwater are available at Moora.
- The proposed disposal of waste water from the Picton site is satisfactory.
- Groundwater requirements at both sites are low, with both the groundwater quality and quantity suitable.
- The process should not adversely affect the groundwater quality in the aquifer.

The mining and rehabilitation proposals are unchanged from ERMP, and are considered satisfactory. The proponent has made a commitment to carry out rehabilitation trials using native vegetation.

In the ERMP response of March 1987, a limit for respirable silica of 5 mg/m^3, and for total silica of 10 mg/m^3 was recommended. It is noted from the PER that normal silica fume stack emission is expected to be in the order of 5 mg/m^3 (section 4.2.5 final paragraph). The American Conference of Government Industrial Hygienists (5th edition 1986) set a respirable limit for amorphous silica of 0.1 mg/m^3 in the workplace. This will be the probable standard to be adopted by the Ventilation Board for worker exposure during the plant's operating life.

...2/-

The limit quoted in Section 7.4.3 paragraph 3 (page 53) of 10 mg/m^3 for respirable amorphous silica is incorrect (see attachment). In fact, it is a total dust limit. Both the total dust and respirable standards are exposure limits and not clean air standards. The issues concerning both silica dust and combustion products will have to be monitored and evaluated post-construction.

The change in the dust collection system reported in the PER replacing the cooler with a cyclone is noted. Monitoring once production starts will be necessary.

The improvement in the design has apparently decreased the silica fume from 18000 tpa quoted in the ERMP down to 8000 tpa quoted in the PER (page 19 paragraph 3), to be sold to the concrete industry.

Organic emissions from the process plant should be free of aromatic hydrocarbons due to the single species of hardwood to be used for charcoal production (Section 4.3.1 of the PER) and the higher temperatures used in the furnace.

Toxic emissions from charcoal fires should be negligible after incineration.

Construction of both the charcoal and process plants at Picton should not create any additional problems over the original separate sites at Coolup and Windowie.

E.J. Blake

A/DIRECTOR GENERAL OF MINES CDB
29 January 1988

encl:

MT677ATN098

SILICA, AMORPHOUS

SiO_2

There are several naturally occurring and synthetic amorphous silicas which differ in their toxic characteristics and accordingly are assigned different TLVs. The different forms are:

Diatomaceous earth
Precipitated silica
Silica gel
Fumed silica
Fused silica

Each is or will be the subject of a separate documentation.

In all forms of silica, SiO_4 (silicate) subunits are linked together to form an infinite lattice. In crystalline forms, the subunits are arranged in a strictly regular geometrical way whereas in the amorphous forms, the units are arranged randomly. The different atomic arrangements are reflected in the X-ray diffraction patterns. Crystalline silicas show discrete reflections from the internal planes formed by the orderly pattern of atoms while in amorphous silicas, X-rays are scattered randomly and no discrete reflections are seen.

SILICA, AMORPHOUS — FUSED

CAS 60676-86-0

SiO_2

TLV-TWA, 0.1 mg/m³ — Respirable Dust*

A colorless, odorless, noncombustible solid, fused silica is formed by heating amorphous silica or quartz to high temperatures. Its physicochemical properties include:

Molecular weight: 60.09

Fused silica is insoluble in water or acids, except hydrofluoric acid.

This type of silica is employed in the aerospace industry as an ablative material in rockets and spacecraft. It is also used in making special camera lenses and in fiber form to reinforce plastics.

There is not enough industrial experience with the dust of fused silica (or fused quartz) to indicate the degree of hazard it presents. Silverman and Moritz[1] found that unfused quartz, following intraperitoneal injection in rabbits, induced a greater tissue reaction than did fused quartz. They attributed this to the greater surface area of the particles of unfused quartz. King *et al*[2] also found fused silica considerably less active than quartz, following intratracheal injection into the lungs of rats.

Fused quartz could be expected to be nearly, if not quite, as fibrogenic as that of crystalline quartz. The toxicology of fused silica is currently a topic of active research. Until further information is available, the same limit recommended for quartz, 0.1 mg/m³ respirable dust, should be used for fused silica dust. Since it is only the respirable fraction of fused silica dust that is medically significant and since measurements of respirable dust concentrations can be made easily, it is recommended that the total dust TLV be deleted. The respirable dust value was adopted in 1985.

The time-weighted TLV for dusts containing fused silica was previously expressed as a function of the percentage of crystalline quartz in the dust. The documentation for Silica Crystalline — Quartz explains the change to the current simple gravimetric TLV.

* The deletion of a TLV expressed in mppcf was proposed in 1983 in favor of one stated in mg/m³, as well as the new TWA values for both total and respirable dust fractions.

References

1. **Silverman, L. and A.R. Moritz:** *Arch. Ind. Hyg. Occup. Med. 1*:499 (1950).
2. **King, E.J., G.P. Mohanty, C.V. Harrison and G. Nagelschmidt:** *Brit. J. Ind. Med. 10*:9 (1953).

SILICA, AMORPHOUS — PRECIPITATED and GEL

SiO_2

Precipitated silica and silica gel containing < 1% quartz

TLV-TWA, 10 mg/m³ — Total Dust*

Precipitated amorphous silica is produced by a number of different companies and production methods vary. Some are furnace products made by heating silicious products; some are manufactured by dehydrating sodium silicate with the use of alcohol; others are produced by burning substances such as ethyl silicate with oxygen or by burning silicon tetrachloride in air.

These dusts have a large surface area (range from < 40 to > 400 m²/gram. The quartz particles, although themselves crystalline, are covered by at least a molecular layer of amorphous silica which may mediate some of the toxic action of quartz.

They are used as fillers for paint, rubber and paper; as a grease thickener, a diluent for insecticides, and as a carrying agent for catalysts, etc.[1]

Klosterkotter[2] investigated the tissue reaction of different kinds of amorphous silica in rats by intraperitoneal and intratracheal injection. Silica gel injected intratracheally resulted in no fibrosis. Four years later, Klosterkotter reported the tissue reaction (peritoneal) to eleven kinds of amorphous silica. He found three kinds of such silica to have no fibrotic reaction. Two of these were dried precipitated silica and one was dried silica gel.[3] In this country Schepers[1] reported that rats exposed to a precipitated amorphous silica for as long as one year, and guinea pigs and rabbits for two years, at a concentration of 126 mg/m³, developed no pulmonary fibrosis. The reaction was limited to macrophage accumulations and mild proliferation of reticulin fibers.

Wilson and co-workers[4] studied the clinical effects of precipitated amorphous silica exposure in 165 workers who had been exposed to this dust for an average of 8.6 years. They found that serial pulmonary function values and chest radiographs were not adversely affected by long-term exposure to this dust. The respiratory symptoms of these workers correlated with cigarette smoking but not with the dust exposure.

Based on these studies, time-weighted averages TLVs of 10 mg/m³ total dust (respirable and non-respirable) were recommended for precipitated silica and silica gel containing less than 1% quartz in 1983 and adopted in 1985. The dusts from percipitated silica and silica gel seem to have little adverse effect on lungs and do not produce significant disease or toxic effect when exposures are kept under reasonable control, therefore, the Committee recommends the elimination of the respirable dust TWA, first proposed in 1983.

References

1. **Schepers, G.W.H.:** *Arch. Ind. Health 16*:125 (1957).
2. **Klosterkotter, W.:** *Die Staublungenerkrankungen 2*:73-84 (1954).
3. **Klosterkotter, W.:** *Ibid. 3*:236-247 (1958).
4. **Wilson, R.K., P.M. Stevens et al:** *Health Effects of Synthetic Silica Partic-*

In spite of the fact that serious injury is not believed likely as a result of exposure to the threshold limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.

The ACGIH disclaims liability with respect to the use of TLVs.

Notice of Intent. At the beginning of each year, proposed actions of the Committee for the forthcoming year are issued in the form of a "Notice of Intended Changes." This Notice provides not only an opportunity for comment, *but solicits suggestions of substances to be added to the list. The suggestions should be accompanied by substantiating evidence.* The list of Intended Changes follows the Adopted Values in the TLV booklet. Values listed in parenthesis in the "Adopted" list are to be used during the period in which a proposed change for that Value is listed in the Notice of Intended Changes.

Definitions. Three categories of Threshold Limit Values (TLVs) are specified herein, as follows:

a) The Threshold Limit Value-Time Weighted Average (TLV-TWA) —the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

b) Threshold Limit Value-Short Term Exposure Limit (TLV-STEL)—the concentration to which workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency, and provided that the daily TLV-TWA is not exceeded. It is not a separate independent exposure limit, rather it supplements the time-weighted average (TWA) limit where there are recognized acute effects from a substance whose toxic effects are primarily of a chronic nature. STELs are recommended only where toxic effects have been reported from high short-term exposures in either humans or animals.

A STEL is defined as a 15-minute time-weighted average exposure which should not be exceeded at any time during a work day even if the eight-hour time-weighted average is within the TLV. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL. An averaging period other than 15 minutes may be recommended when this is warranted by observed biological effects.

c) Threshold Limit Value-Ceiling (TLV-C)— the concentration that should not be exceeded during any part of the working exposure.

In conventional industrial hygiene practice if instantaneous monitoring is not feasible, then the TLV-C can be assessed by sampling over a 15-minute period except for those substances which

may cause immediate irritation with exceedingly short exposures.

For some substances, e.g., irritant gases, only one category, the TLV-Ceiling, may be relevant. For other substances, either two or three categories may be relevant, depending upon their physiologic action. It is important to observe that if any one of these three TLVs is exceeded, a potential hazard from that substance is presumed to exist.

The Committee holds to the opinion that limits based on physical irritation should be considered no less binding than those based on physical impairment. There is increasing evidence that physical irritation may initiate, promote or accelerate physical impairment through interaction with other chemical or biologic agents.

Time-Weighted Average vs Ceiling Limits. Time-weighted averages permit excursions above the limit provided they are compensated by equivalent excursions below the limit during the workday. In some instances it may be permissible to calculate the average concentration for a workweek rather than for a workday. The relationship between threshold limit and permissible excursion is a rule of thumb and in certain cases may not apply. The amount by which threshold limits may be exceeded for short periods without injury to health depends upon a number of factors such as the nature of the contaminant, whether very high concentrations —even for short periods — produce acute poisoning, whether the effects are cumulative, the frequency with which high concentrations occur, and the duration of such periods. All factors must be taken into consideration in arriving at a decision as to whether a hazardous condition exists.

Although the time-weighted average concentration provides the most satisfactory, practical way of monitoring airborne agents for compliance with the limits, there are certain substances for which it is inappropriate. In the latter group are substances which are predominantly fast acting and whose threshold limit is more appropriately based on this particular response. Sustances with this type of response are best controlled by a ceiling "C" limit that should not be exceeded. It is implicit in these definitions that the manner of sampling to determine noncompliance with the limits for each group must differ; a single brief sample, that is applicable to a "C" limit, is not appropriate to the time-weighted limit; here, a sufficient number of samples are needed to permit a time-weighted average concentration throughout a complete cycle of operations or throughout the work shift.

Whereas the ceiling limit places a definite boundary which concentrations should not be permitted to exceed, the time-weighted average limit requires an explicit limit to the excursions that are permissible above the listed values. It should be noted that the same factors are used by the Committee in determining the magnitude of the value of the STELs, or whether to include or exclude a substance for a "C" listing.

Excursion Limits. For the vast majority of substances with a TLV-TWA, there is not enough toxicological data available to

Department of
Occupational Health,
Safety and Welfare
of Western Australia

Your Ref
Our Ref
Enquiries Mr Archer
Date 1 February 1988

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

ATTENTION: MR J MALCOLM

BARRACK SILICON PROJECT - PUBLIC ENVIRONMENTAL REPORT

Careful consideration has been given to the Public Environmental report for the proposed Barrack Silicon project, particularly in regard to the following occupational health and safety matters.

1. **NOISE**

As is usual in this type of assessment the emphasis is on environmental noise rather than occupational noise. However, Appendix C (Noise Analysis) points out that the Noise Abatement (Hearing Conservation in Workplaces) Regulations 1983 will require a preferred equivalent continuous noise exposure level of 85 dB(A) to any personnel. The report also notes that these occupational noise criteria may well in some cases, override the requirements for neighbourhood annoyance, (page 9 of Appendix C).

Occupational noise is also addressed in Section 7.4.4 (Noise Emissions, page 62) where it is noted that noise hazards may exist in the baghouse and furnace areas and that engineering design of the plant is continuing with the objective of reducing potential noise levels. In the final paragraph of Section 7.4.4 (page 66) it is indicated that the project will only implement certain of the attenuation measures identified in Appendix C at the construction stage with other measures only being implemented after construction should it be shown by measurements to be necessary.

WILMAR HOUSE, 600 MURRAY STREET, (P.O. BOX 294), WEST PERTH 6005, WESTERN AUSTRALIA
TELEPHONE (09) 327 8777, TELEX "DOSHWA" AA93346, TELEGRAPHIC ADDRESS "DOSHWA" PERTH

From the occupational noise standpoint this approach is not considered to be entirely satisfactory and the following points should be taken into account:

1.1 The proponent should expand its noise policy in terms of:

- 1.1.1 the design goal for general plant noise levels.
- 1.1.2 the noise specification limits for individual plant items.
- 1.1.3 the enclosure of noisy items (eg. compressors) in treated plant rooms.
- 1.1.4 the internal treatment of buildings (eg. by application of absorptive linings) to reduce noise levels.
- 1.1.5 the treatment of workshop facilities for noise control.
- 1.1.6 the treatment of operator booths to minimise noise and vibration.

1.2 Apart from the baghouse and furnace, there appear to be other items in Table 1 of Appendix C capable of generating high noise levels. These may include mobile equipment, docking mill, debarker, charcoal retort fans, sledgehammer, mould-breaking, shotgun, stinger, ladle cleaning and the crushing and screening plant. Other items not in Table 1 include storage bins, conveyor lines, vibratory feeders and air compressors. These items should come under the above noise policy.

1.3 The use of the shotgun tapping process is considered to be capable of generating peak noise levels higher than 140dB(LIN) which can cause instantaneous damage to hearing. An alternative to this operation should receive special consideration.

2. OCCUPATIONAL HEALTH

Certain operations including feeding/discharge; loading/unloading/ the maintenance of mechanical handling equipment; silicon reduction furnaces and charcoal retorts may result in workers being exposed to substances at levels that are hazardous to health. Effective engineering controls (eg. enclosure, extraction ventilation, other wet dust suppression methods and process mechanisation/automation) are required to minimise worker exposure to the following:

2.1 Wood dust - in this case hardwood, some varieties of which can cause nasal cancer and a Threshold Limit Value (TLV) of 1 mg/m^3 is recommended.

2.2 Charcoal dust - the recommended TLV is 3.5 mg/m^3 which is set to minimise carcinogenic risk.

2.3 Silica fume and dust - industrial experience with the dust and fume of high temperature produced amorphous silica and fused silica is limited.

It is recommended that an occupational exposure standard (OES) of 2 mg/m^3, as proposed by Worksafe Australia for fumed silica, be adopted in this situation. Further, it has been found that exposure to inert dusts including amorphous silica fume and amorphous precipitated silica can cause epistaxis (nose bleeds) as a result of the desiccating effect of the particulate material deposited on the nasal mucosa.

A further review of the information provided on 29 January by Mr Malcolm is underway and additional comment on this issue will follow.

2.4 Quartz dust - the current recommended TLV is 0.2 mg/m^3 for respirable quartz (the proposed Worksafe OES is 0.1 mg/m^3). Additionally the recommended TLV for respirable dust of 5 mg/m^3 should be observed.

The information in this submission may be fully utilized by the EPA and the proponent and may be included in the EPA assessment report as required.

Rex Archer
SCIENTIFIC OFFICER
OCCUPATIONAL HYGIENE BRANCH

RA0001F

Department of
Occupational Health,
Safety and Welfare
of Western Australia

Your Ref:
Our Ref:
Enquiries: R Archer
Date 19 February 1988

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

ATTENTION: Mr J Malcolm

BARRACK SILICON SMELTER PROPOSAL - PICTON

The additional documentation concerning the above project has been examined, particularly in relation to the Occupational Health implications of the amorphous silica fume likely to be generated by the proposed smelter.

It is clear from the literature that the health effects of amorphous silica fume remain an issue of some contention. However the recommended occupational exposure standard (OES) proposed by Worksafe Australia for fumed silica of 2 mg/m^3 has been based on the best available information.

This department acknowledges this OES but would take immediate steps to revise the standard in the event that further substantial research comes to light.

As an additional safeguard it is suggested that an 'action level' of 1 mg/m^3 be established in regard to occupational exposure to amorphous silica fume. If, on the basis of personal monitoring of exposed workers, this level (as an eight hour time weighted average) is exceeded then a thorough examination of dust and fume control measures should take place and remedial action instituted at once.

WILLMAR HOUSE, 600 MURRAY STREET, (P.O. BOX 294), WEST PERTH 6005, WESTERN AUSTRALIA
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It is noted from page 15 of the supplementary document produced in January 1988 on behalf of the proponent that all samples of fumed silica will be examined by x-ray diffraction for the presence of crystalline silica. It is expected that this procedure would be adopted for the examination of all such samples acquired through personal monitoring of exposed employees.

The above information may be fully utilized by the EPA and the proponent and may be included in the EPA assessment report as required.

Rex Archer
SCIENTIFIC OFFICER
OCCUPATIONAL HYGIENE BRANCH

RA0003F

STATE PLANNING COMMISSION

GOVERNMENT OF WESTERN AUSTRALIA

22 ST. GEORGES TERRACE,
PERTH, WESTERN AUSTRALIA 6000
TEL: (09) 426 7333
FAX: (09) 325 4173

YOUR REF: 176/80

OUR REF: 55/6/9/2

ENQUIRIES: Mrs L Farrell/MR

February 19, 1988

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Dear Sir

BARRACK SILICON PROJECT
PUBLIC ENVIRONMENTAL REPORT

I refer to the abovementioned project.

Comments on the Public Environmental Report for the Barrack Silicon Project are forwarded herewith.

Yours faithfully

G. Smith

GORDON G SMITH
SECRETARY

Attach.

BARRACK SILICON PROJECT

PUBLIC ENVIRONMENTAL REPORT

1. Outline of Project

1.1 Barrack Silicon Pty Ltd is proposing to establish a Silicon industry in Western Australia. The three main components of the proposal are:-

(i) Quartzite quarrying at Moora

(ii) Jarrah cutting and carting from Harvey and Collie

(iii) Charcoal/silicon production at Picton

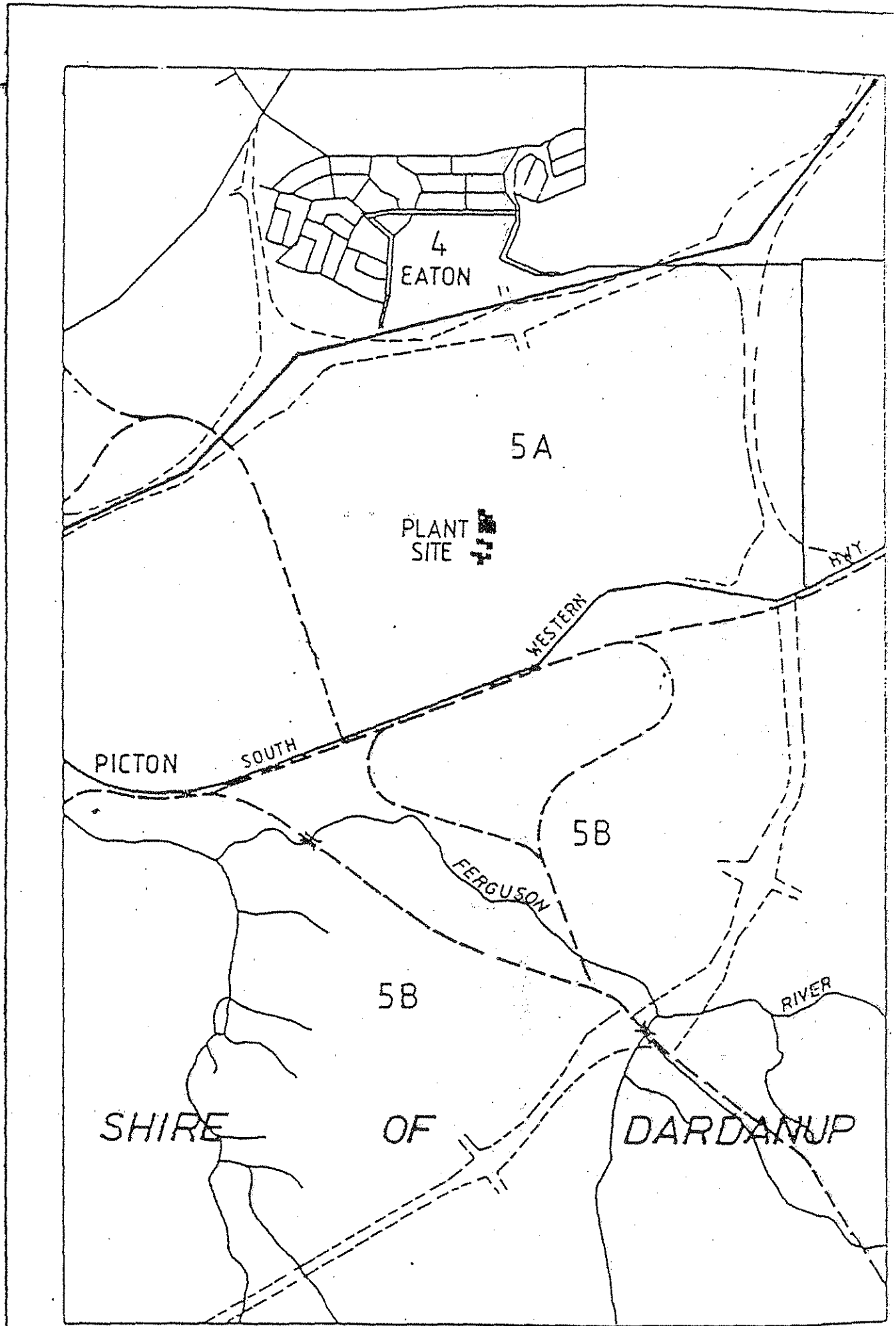
The quarrying of quartzite has been the subject of an ERMP (Wundowie) and has been through a public review period

The latter two components of the proposal are largely the subject of the Public Environmental Report.

1.2 Silicon is produced by the high temperature reduction of quartzite in a submerged arc furnace (electric). Charcoal and wood blocks (Jarrah) are added to the furnace as a reductant and stabilising agent respectively. The silicon metal is tapped through holes at the bottom of the furnace and cast in moulds.

1.3 The preferred species of wood (Eucalyptus Marginata - Jarrah) will be extracted from the Yarloop and Collie areas at a rate of 126,000 m^3 per annum. Logs extracted will be below second grade sawlogs and the Department of C.A.L.M. has stated that sufficient quantities are available to meet the 20 year life of the silicon project. The proponent states that the extraction proposed is consistent with the General Forest Working Plan No. 87 and the Central Forest Management Plan.

1.4 The proposed plant operations are to be sited in Picton on 3 locations (currently owned by the South West Development Authority) totalling an area of 191 hectares. (See Map 1). The area is locally know as the Picton Industrial Area and is within the Shire of Dardanup.


4
EATON
5A
PLANT
SITE
RWY.
WESTERN
PICTON
SOUTH
5B
FERGUSON
5B
RIVER
SHIRE OF DARDANUP

MAP 1

1.5 The State Government has facilitated the location of the plant in Picton through the agency of the South West Development Authority and the passing of the Silicon (Picton) Agreement Act on December 9, 1987.

1.6 The Shire of Dardanup Council has initiated action to zone the subject land Industry and has prepared a structure plan to establish buffer areas, access roads and communication corridors (as required by the Bunbury Region Plan).

1.7 The proposed plant is approximately 1.5 kilometres from future residential areas in Eaton and Glen Iris (City of Bunbury). Local public opinion is strongly against the smelter being located at the preferred site. Eaton residents in particular have mounted a substantial campaign in opposition.

2. Major Impacts

2.1 Air Emissions. The principal by-product from silicon production is amorphous silica dust which is collected in bag houses and subsequently sold. It is estimated that 0.2% of total dust produced will escape, however direct venting (i.e. no collection) will occur in emergencies and start ups.

2.2 Noise Emissions. Of major concern is the potential noise emmissions from the proposed silicon complex. The proponent addresses the issue of whether the noise generated by the plant meets the standards required by the noise regulations of the Environmental Protection Act.

2.3 Wood Transportation. The project will require 14 round trips (28 to and from) over 230 days of the year with an average truck load of 40 tonne. Several of the haulage roads may be described as scenic roads.

2.4 Visual. The plant will be considerably higher than any existing structures in the near vicinity and will be particularly noticeable from the South West Highway.

3. Regional Planning Implications

3.1 Although 'planning' necessarily addresses the socio-economic impacts of major developments, the State Government has decided that the project will yield greater benefits to society than costs; hence the Agreement Act. To maximize social benefits, the issue of social costs created by adverse environmental impacts places high importance on the location of the plant. The Bunbury Region Plan, which has been adopted by the Commission and launched by the Hon Premier in August 1987, provides the framework to assist in the selection of an appropriate site.

3.2 With reference to Map 2 the existing and future industrial areas to service the Port and region are shown. These areas were identified as a result of research into groundwater pollution, atmospheric conditions, location of services, proximity to the port, proximity to existing and future residential areas, location of existing industrial uses and opportunities for buffers between incompatible uses.

3.3 The abovementioned research was applied further to establish more detailed guidelines for the location of different types of industry within the industrial areas. In general terms, the intention is to optimize servicing opportunities (e.g. road, rail, power transmission), optimize the use of land close to the port and most importantly to ensure that the amenity of adjoining residential areas is not adversely affected. In this regard the Bunbury Region Plan includes policy statements for industrial areas, a plan of buffer zones (classes of industry) a table of industry types and their classification and; a list of major industries requiring detailed environmental assessment (e.g. P.E.R. or E.R.M.P.).

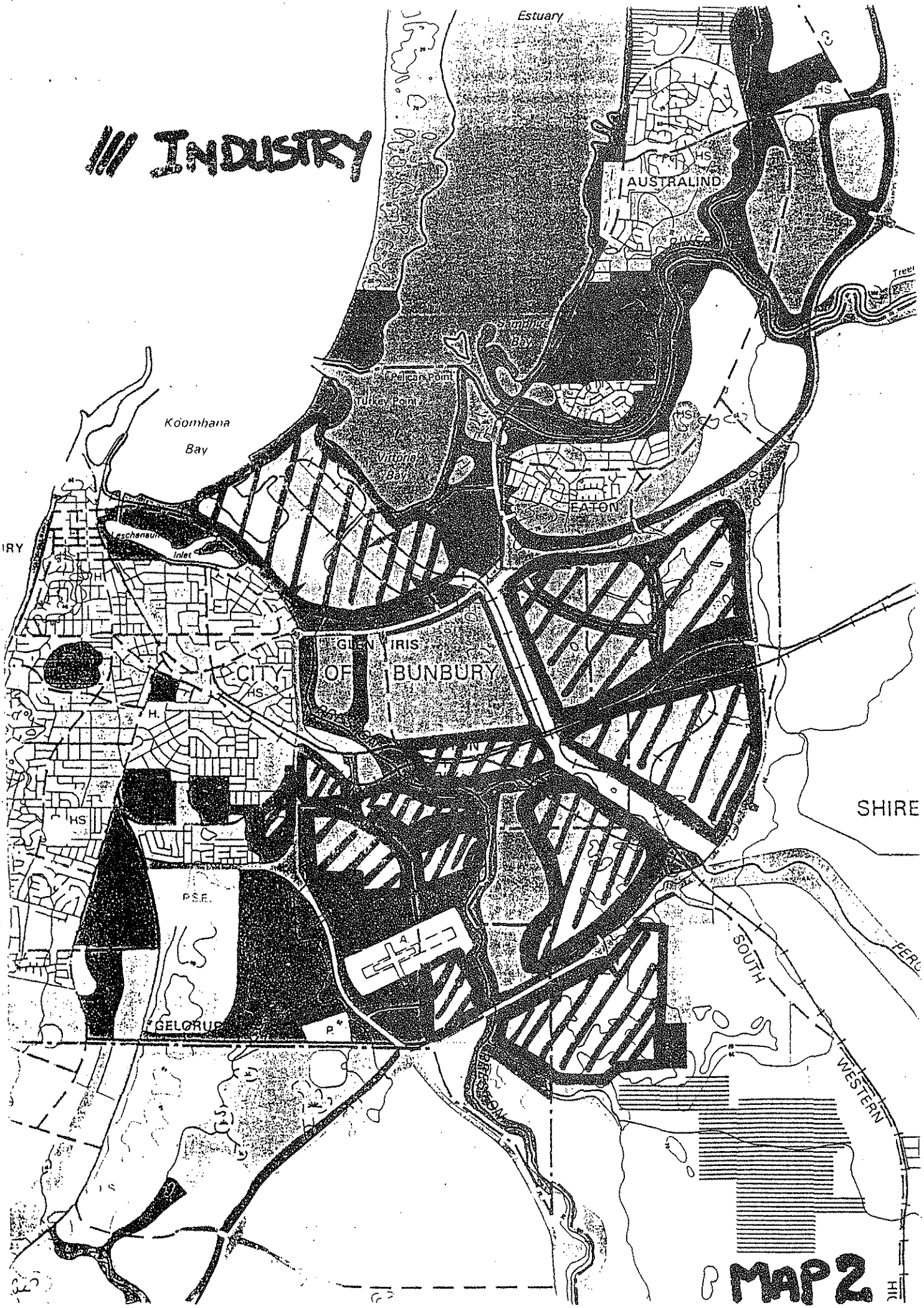
3.4 The area the subject of the P.E.R. is;

(i) Within Policy Area 5 and precinct A. The Region Plan states;

"(a) The predominant use should be, in precinct;

A - road and rail served general industry requiring access to the port

B - road and rail served general industry.


INDUSTRY
Estuary
AUSTRALIND
Sandpiper Bay
Pelican Point
Turkey Point
Koombana Bay
Vittoria Bay
EATON
Inlet
GLEN IRIS
CITY OF BUNBURY
SHIRE
SOUTH
WESTERN
GELORUP
P.S.E.
MAP 2

(b) the Picton policy area should be subject to overall industrial planning with inbuilt flexibility to cater for a wide range of site and servicing requirements. Such plan should be approved by the Local Authorities and the State Planning Commission.

(c) Planning should provide for;

- service corridors and buffers
- the flight path and radio interference constraints of Bunbury Airport
- road reserves and adjacent buffers
- railway reserves
- the environmental amenity of the Preston and Ferguson River systems
- S.E.C. high tension power lines

(d) Industrial development within the Picton policy area should satisfy the environmental assessment requirements relating to airbourne gaseous emissions, dust noise, groundwater pollutants and provide safeguards for both worker and resident health and safety.

(e) Industrial waste water disposal into the river systems should be the subject of environmental assessment and ongoing monitoring."

(ii) generally within a Class II/III industry zone (medium - heavy) as defined by Map 15 - Isopleths.

(iii) classified as a Class II industry in Appendix A, Table I (non ferrous smelter).

(iv) indentified in Appendix A, Table II as an industry requiring individual detailed assessment in determining location.

3.5 The most significant factor affecting the location of the plant (in the context of the Region Plan) is the application of the isopleth map. (An isopleth represents a constant concentration of pollutant some distance from the source). The Region Plan stresses that the map is a preliminary planning tool and should be regarded as a first guide to locating industry. The map and industry classification is a synthesis of research undertaken by David Rigden of the Public

Health Department and the Israeli Government. The main basis for classification is gaseous or particulate emissions although fire hazard, noise and liquid effluent disposal were included.

The guidelines contained in the Region Plan are based on incomplete data on atmospheric conditions and David Rigden in his report on the application of climatological data to zoning of industrial and residential areas states:-

'When detailed information on the interaction of climate and industrial emissions in the area become available, it may be possible to allow extension of either the heavier industrial areas, or of the housing areas, into the preliminary buffer zones.'

The recommended average buffer distance for a Class II industry is 1000 m from a residential area. The proposed plant is between 1000 m and 1500 m from the suburbs of Eaton and Glen Iris.

3.6 Given the requirement of the Bunbury Region Plan that a non ferrous smelter requires individual detailed environmental assessment in determining location, and that the industrial buffer zones are a guide only based on incomplete climatic data, the actual location of the plant is largely dependent on the E.P.A. assessment of the environmental impacts.

3.7 With reference to Map 2, areas designated as Industry under the Region Plan adjacent to the proposed plant site were investigated by the proponent as alternative sites. Generally land to the east and south east of the proposed plant site has been shown on the buffer zone map as heavy industry, and on first impressions would appear logical locations for the project. However, a number of constraints in these areas such as proximity to the airport, proximity to power transmission lines, proximity to Special Rural areas, drainage and wetlands, soils and landform and; proximity to the port road and rail have influenced the proponent in selecting the proposed site.

Whilst it is acknowledged that the abovementioned constraints exist, it is contended that in some areas (e.g. Policy Area 5B - See Map 1) it would be possible to undertake works to eliminate many of the constraints. This may lead to extra site costs (e.g. fill and drain, roads, realigned power transmission lines) however, the long term social costs of incompatibility with adjoining uses in locations closer to residential areas may outweigh the short term costs of solving site problems in areas further away.

In this regard an analysis of costs and benefits of alternative sites over time expressed in Present Value terms should be undertaken. This would necessarily involve quantifying in dollars negative externalities such as noise, dust and liquid effluent.

Summary

The P.E.R. promotes a strong case to establish Barrack's silicon project within the area designated as Industry under the Bunbury Region Plan and on a site contained within policy area 5A.

As outlined in the above report the Region Plan provides a guide to assist in planning the location of industry within appropriately "zoned" areas. Although there is some conjecture as to the precise interpretation of the Region Plan Rigden lines, it is contended that there is sufficient justification in planning terms to advance a detailed proposal on the site subject to environmental clearance and compliance with an approved structure plan.

Concern is however raised over the analysis of alternative sites, especially those that would be clearly located within a heavy industry classification. Given the substantial public opposition to the project on the present site and some doubts about the environmental acceptability of particularly noise and dust emissions, it would seem appropriate to fully investigate alternative sites. Such a planning study should establish the costs to society over time of any likely adverse impacts. These costs may be significantly higher than the extra short term costs associated with an alternative site.

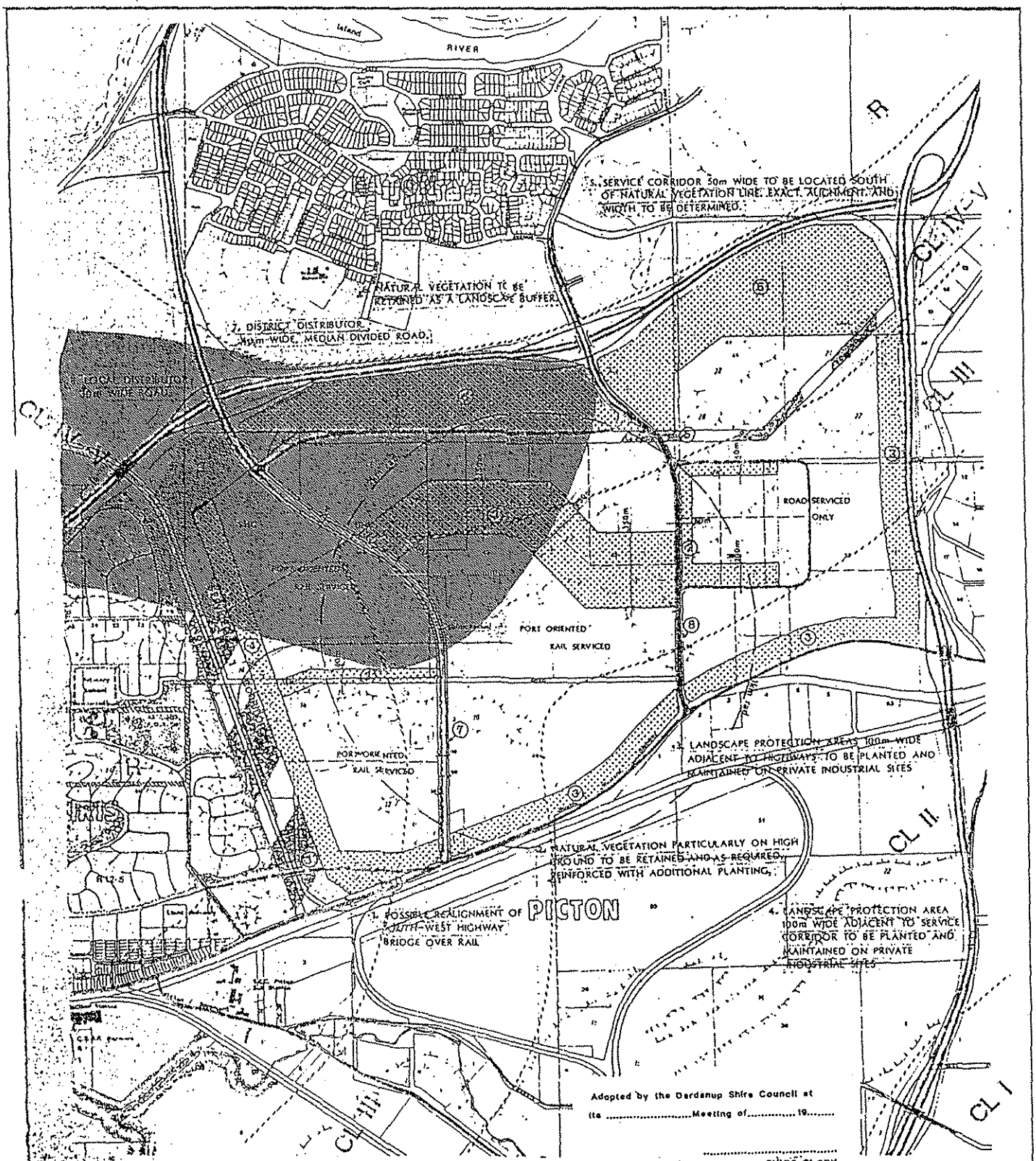
4. District Planning Implications

4.1 The proposed development is located within the Shire of Dardanup, although plant operations will affect the adjoining City of Bunbury. As previously stated, policy area 5 of the Bunbury Region Plan requires overall industrial planning which takes account of service corridors and buffers, road and rail reserves, transmission lines, flight paths and the environmental amenity of the Preston and Furguson Rivers.

4.2 The structure planning for the industrial area is an important prerequisite to zoning and development. The Shire of Dardanup Council and the City of Bunbury Council have adopted a structure plan for the area and resolved to amend their District Zoning Schemes to zone the land; General Industry, Service Corridor and Landscape Protection.

4.3 Picton Policy Area Structure Plan (See Map 3)

The objectives of the structure plan are stated as:-



PICTON POLICY AREA STRUCTURE PLAN

PLAN No. 87/62/1
DATE 2nd DECEMBER 1987

SCALE 1 : 10,000

RIDGED LINES ~~~~~ Refer : Bunbury Region Plan
R : EXISTING & FUTURE RESIDENTIAL
CL IV-V : LIGHT AND BUFFER ZONE CLASS IV & V
CL III : MEDIUM IND. CLASS III
CL II : HEAVY IND. CLASS II
CL I : NOXIOUS IND. CLASS I
AREAS FROM WHICH DUSTY INDUSTRY SHOULD BE EXCLUDED

FIG. 6

RUSSELL TAYLOR & WILLIAM BURRELL Consultants in Town Planning & Civic Design 187 Roberts Road, Subiaco W.A. 6008...382 2911

MAP 3.

(i) To provide a non statutory framework for the subdivision and development of the cell within the context of the Bunbury Region Plan, the City of Bunbury Town Planning Scheme No. 6 and the Shire of Dardanup Town Planning Scheme No. 3;

(ii) To provide a physical planning and servicing rationale for this industrial cell which will permit development proposals to proceed in stages;

(iii) To ensure that any negative impact on the adjoining residential areas created by industrial activities will be contained within specified standards.

The size of the policy area is 659 hectares of which approximately one third is located in the City of Bunbury. The land is either vacant or semi rural and substantial areas are uncleared or semi cleared. Several power transmission lines traverse the site.

The structure plan recognizes five land units, including level to undulating, moderate slopes and heavy tree cover and; ridges with medium to heavy tree cover. This type of classification assists in defining buffer areas, drainage characteristics, road alignments and other servicing requirements.

The site can be serviced by water (ground), electricity (132 kv), gas, telecom, sewerage and has easy acces to rail and major roads. Provision is made for the location of services in service corridors on th periphery the site. The structure plan shows the preferred location of internal roads (connecting the regional road system), one of which is the subject of an application for subdivision.

The proposed structure plan has been referred to the Water Authority, City of Bunbury, E.P.A., S.E.C., Telecom, Westrail, Main Roads Department and the Department of Resources Development. Responses are as follows:-

W.A.W.A. - satisfied with the contents of the plan.

City of Bunbury

- endorse structure plan subject to the distributor road affecting lots 5 and 41 being moved 10 metres east.

E.P.A. - generally acceptable however objective (C) is overstated, no mention is made of the meteorology of the area and no mention is made of the role of L.I.M.A. and the E.P.A. in controlling effluent into water courses.

S.E.C. - requests a new east-west service corridor and modifications to Section 4.2 of the Report.

Telecom - no objections

Westrail - no objections

M.R.D. - highlights need for intersection treatments with South West Highway. Need to consider additional width to buffer strip along South West Highway to cater for future road widening.

Dept Resources Development

- include reference to Rigden Lines as preliminary techniques only. Provision needs to be made for services to traverse buffer areas.

The structure plan is in accordance with the Policy Statements of the Bunbury Region Plan (as adopted by the Commission) and provides a sound basis upon which to base statutory planning decisions. it is therefore recommended that it be adopted, subject to minor modifications.

4.4 Shire of Dardanup Town Planning Scheme No. 3 Amendment No. 26

The amendment proposes to rezone the land contained within Policy Area 5A of the Bunbury Region Plan and within the Shire of Dardanup from "General Farming" to "General Industry", "Service Corridor" and "Landscape Protection."

The Service Corridor zone is to be introduced into the zoning table and on the Scheme maps and the only uses permitted are railways; water supply, sewerage and drainage; electricity generation; gas manufacture and storage; parks and recreation; natural countryside and; forestry.

A policy statement has been introduced into the Scheme Text (3.18) which promotes a high standard of visual amenity and safeguarding of the environment of adjoining residential areas. It also sets requirements for landscaping, noise levels, fencing, buffers and servicing.

The proposed amendment is in accordance with the regional objectives adopted by the Commission and the structure plan adopted by the Shire of Dardanup and the City of Bunbury.

The amendment is to facilitate the establishment of an industrial estate and it is a requirement of the Silicon (Picton) Agreement Act.

The Scheme Amendment was referred to the same Authorities as summarized in the previous section on the Structure Plan. Specific changes recommended to the proposed provisions of the text are as follows:-

E.P.A. - Paragraph 3 of clause 3.18.1 is too rigid. (Rigden Lines). Reference should be made to air and water pollution as well as noise pollution.

S.E.C. - Provision to be made for a new east west service corridor.

Dept Resources Development

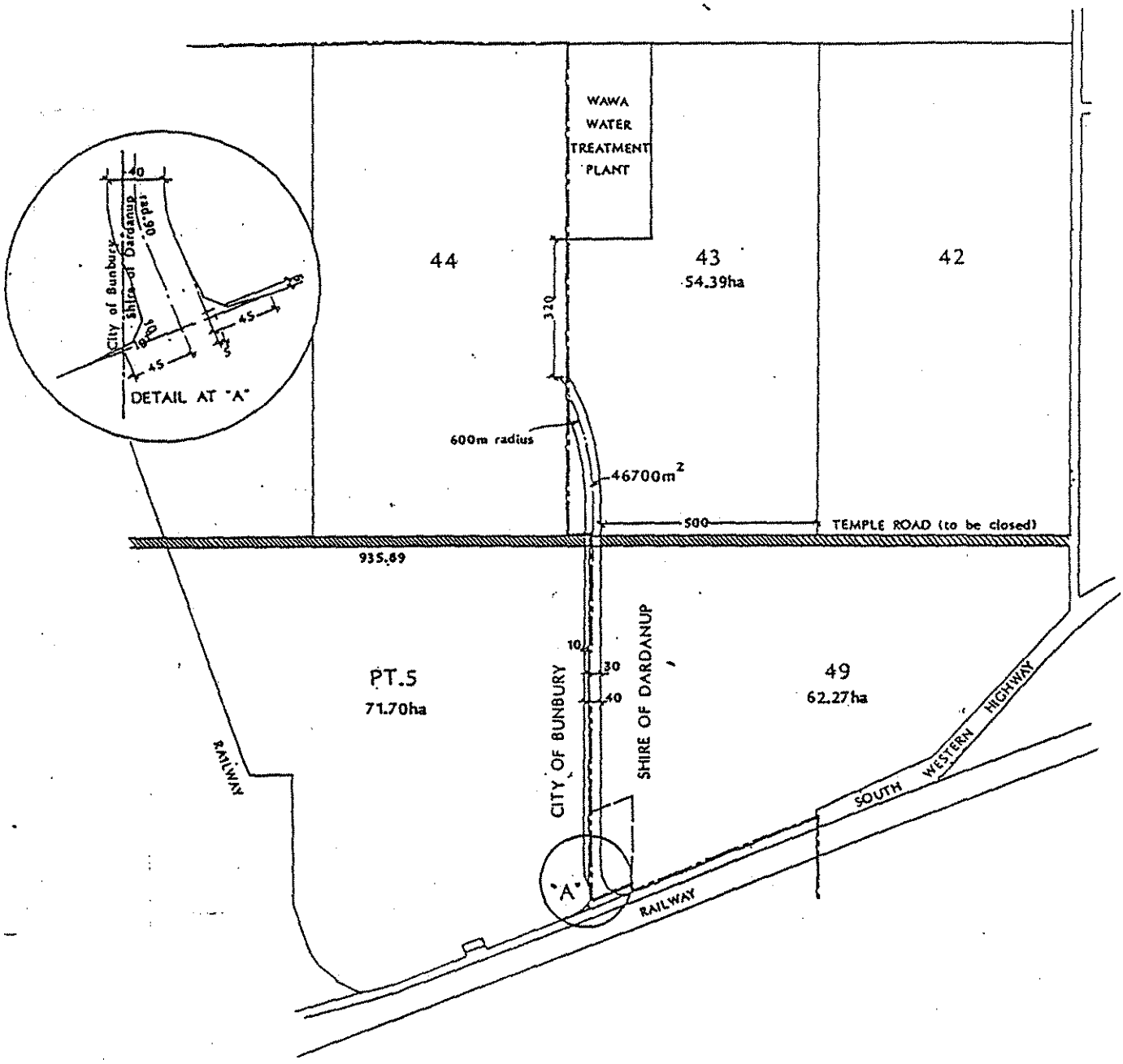
- Paragraph 3 of Clause 3.18.1 should be amended.

No objections are raised to the proposed amendment.

4.5 Shire of Dardanup - Proposed Subdivion of Lots 43, 49 and Pt 5. (See Map 4)

The South West Development Authority (the owner of the land) has submitted an application to create a 40 metre wide public road to service the Picton Industrial Estate. The road forms part of the structure plan for the area.

Both the Shire of Dardanup Council and the City of Bunbury Council have requested that the road be moved approximately 10 metres east to ensure that it is wholly located within the Shire of Dardanup. Other minor conditions have been requested by the Water Authority and the Main Roads Department. No objections are raised to the proposal.



FILE 74961

MAP 4.

PROPOSED SUBDIVISION LOTS 43,49 AND PT.5
TO CREATE A 40m WIDE PUBLIC ROAD

N

SCALE 1:12500

Westrail

The Western Australian Government Railways Commission
Westrail Centre, West Parade, East Perth. Tel: 326 2222 Telex WARAIL AA92879
Westrail, GPO Box S1422, Perth 6001

Enquiries

My Ref 8943

Your Ref 176/80

Date February 11 1988

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

PROPOSED SILICON PROJECT - PICTON; PUBLIC ENVIRONMENTAL REPORT YOUR LETTER OF NOVEMBER 27 1987

ATTENTION: Mr J Malcolm

Dear Sir

Westrail has been involved in current discussions with Barrack Silicon Pty Ltd and we have tendered for the mining and rail transport of Silicon Quartz from Cairn Hill to Picton and for the transport of the finished products "Silicon" from Picton to North Fremantle.

Barrack Silicon Pty Ltd have indicated the acceptance of our tender and requested a draft agreement which was duly prepared and forwarded to the company.

Westrail, in order to achieve a door-to-door transport task will have to construct a rail siding at Cairn Hill and Picton (adjacent to the smelter complex).

The transport of the above mentioned product will be carried out under transport regulations as set down and in accordance with the Environmental Protection Authority guide lines.

Yours faithfully

Bruce Sutherland
ASSISTANT COMMISSIONER

YC8TM1/JMC

016027

7530-022-593

APPENDIX F

TASMANIAN INSPECTION TOUR REPORT

REPORT OF AN INSPECTION TOUR

OF THE

PIONEER/PECHINEY SILICON SMELTER

AT

ELECTRONA, TASMANIA

AND THE

BHP/TEMCO FERROSILICON SMELTER

AT

BELL BAY, TASMANIA

by
Jim Malcolm
Senior Environmental Officer
Environmental Protection Authority of W. A.

January, 1988

INTRODUCTION

This study tour was undertaken to assist in the assessment of a proposal to establish a silicon smelter at Picton, near Bunbury in the South West of Western Australia.

The Report is deliberately anecdotal, and records my impressions and feelings as well as objective information because personal reactions form part of a complete environmental assessment.

Reference is made in the Report to the Public Environmental Report (PER) prepared for the proposed Picton smelter. Comparisons are drawn not with the aim of praising or criticising the operation or control of the Tasmanian plants, but to place the Picton proposal in perspective.

ACKNOWLEDGEMENTS

I am most grateful for the ready assistance of the following people:

Trevor Brown (Director) and Bob Chesterman of the Tasmanian Department of the Environment;

Clive Peterson (Manager) of the Pioneer/Pechiney Silicon Smelter at Electrona; and

Terry Howard (Deputy Manager) and Mark Fontana (Superintendent, Silicon and Production Services) of the Temco (BHP) Smelting Plant at Bell Bay.

1. DEPARTMENT OF THE ENVIRONMENT

On arrival in Tasmania, my first call was at the office of Trevor Brown, Director of the Department of the Environment(DOE). Our discussion centred around the assessment, establishment and operation to date of the Electrona silicon smelter.

Noise

Trevor indicated that although noise had been a cause for some complaints, the Department had been investigating complaints and working with the company on solving them, and as a result the frequency of complaints had decreased.

Since the plant had been operating, there had been only occasional complaints from Electona and Snug, the nearest settlement. Having visited the site this does not surprise me, as many of the houses in Electrona are owned by the company, and although the nearest houses in Snug are just 550 metres from the plant, there is a wooded ridge which screens the plant, making it less visible and less audible. Also a proportion of the population derives employment from the plant and is therefore less likely to be critical of it.

Most complaints have come from the settlement of Howden and the hobbyfarms at Tinderbox West, across North West Bay at distances of 4.5 km and 5 km from the plant. Again, having visited these settlements and spoken with some of the people I am not surprised. Howden is a small settlement, much smaller than either Eaton or Clifton Park, with perhaps thirty houses dotted along the shore. Further out, along a gravel road, the hobby farms fringing the lake are fewer and more widely scattered.

These residents have gone to some effort to get away from suburbia - even the relatively relaxed suburbia of places like Eaton and Clifton Park. They have always been able to look across the lake and see the Plant on the opposite shore. But now it is operating, and the appeal process has ensured that they are well aware of the noises it is likely to make. They are understandably alert and listening for anything which might disturb their rural peace and quiet.

Add to this the location of the plant, on the water's edge, and the positioning of the baghouse which has been dug into the bank of the lake. The excavation protects most shore-ward residents, but may act as a shell adding to the transmission of noise across water.

According to Trevor Brown, noise complaints are relatively infrequent - two since Christmas - and confined to still days with heavy cloud. The nature of the surrounding landscape is something of a large bowl, and this may contribute to the frequency of these conditions.
On occasions when there have been complaints, DOE officers have rushed out to investigate, but have not so far been able to measure any noise problem. On one occasion the Director and the Minister for the Environment (who is also the local member for the area) went out late at night to investigate a complaint. They stood with the complainant, and could not hear the noise being complained of.

Descriptions of the noise have varied from "an occasional low hum" and "a thump-thump-thump" to "a burst of noise like an express train". DOE investigations at the plant have failed to locate any source of low frequency noise (around 110 Hz) which could be responsible for the sounds described.

There are large refrigeration plants on the shore, closer to Howden and Tinderbox West which would generate noise as they start up through the night. They were in existence without complaint before the plant commenced, but it could be that concern over the smelter has sensitized residents to noise.

Dust

With regard to dust emissions, both the company and DOE have been monitoring since before the plant was commissioned. DOE has low volume dust monitoring stations at Snug and Margate Primary Schools (1.2 km and 3.2 km from the plant respectively), and at the recreation ground which lies between Snug and the plant. The DOE monitoring stations have not found any measurable increase in dust levels.

At the recreation ground there is also a 16 mm time lapse camera focussed on the furnace stacks to detect direct venting, but inspection of the films has shown little visible evidence of dust.

The sulphur content of the coal used in the furnace means that the colder gasses given off as the furnace cools could damage bags in the baghouse. Because of this the company's need to bypass the baghouse is greater than for the Picton smelter using charcoal. The Electrona smelter therefore has a direct venting allowance of 200 hours per annum compared with the 50 hours proposed for the Picton smelter. Also the special silicone treatment of the bags is sensitive to the moisture which can condense at lower temperatures.

The 200 hour allowance covers the period of normal operation, and for the commissioning period a separate additional allowance was specified. Trevor recommended this separate treatment of the commissioning period but pointed out that it was not well understood, and it was perhaps because of this that some people believed that the company may have exceeded its 200 hour allowance when in fact this was not the case.

Monitoring of the dust collected in the baghouse during commissioning has shown that rarely, under "flare" conditions there is a considerable percentage of crystalline silica in the dust. These conditions occur when due to poor porosity and/or inadequate stoking, there is crusting over of the furnace, a bubble of silicon monoxide gas forms and explodes as it oxidises. Under these conditions heat is lost and the furnace does not operate efficiently, so it is in the company's interest to ensure that they do not occur.

2. ELECTRONA SILICON SMELTER

I visited the Electrona plant in company with Trevor Brown and Bob Chesterman, the DOE officer who has just taken over responsibility for supervising the monitoring of the plant. Given their inspectorial role, the Company may have felt somewhat inhibited in the discussions, but their presence was invaluable for the background it provided.

Clive Peterson, the Manager, showed us around and answered our questions. He is only there in the short term on a contract basis until a more permanent appointment is made.

Noise

Clive said that the company was trying to get close to the people over the noise issue. He said that the level of objections and complaints had dropped and that of late the tone of the objectors had almost been conciliatory, suggesting that they realised that the company was trying to do the right thing.

The company was monitoring the noise from a house in Connington to find the low rumble complained of. Nothing could be found to date, but if something was found he recognised that the company had a duty to reduce it.

He pointed out that the company had done several things to reduce noise. A shotgun was used occasionally to clear taphole plugs, but to reduce night time noise the shotgun was not used at night. Also there was no yardwork and reduced use of conveyors at night.

Wooden doors/fences had been erected between the sides of the baghouse and the earth bank surrounding it to help contain the noise of the fans. Measurements indicated a 5db reduction in noise from one side of the fence to the other.

I was surprised to find that in the Manager's office, with the window open the only outside noise I noticed was the sound of the wind in the trees. It was a gentle wind blowing from the direction of the baghouse, about 150 metres away.

Walking around the plant, the major sources of noise were the furnace and the baghouse, with the reversing beeper on the front end loader occasionally heard. The furnace was operating on slightly reduced power while we were there; I do not know why; but the baghouse was in full operation.

Leading from the furnace to the baghouse there is a long pipe of large diameter. The length of the pipe helps cool the gasses to the best temperature for baghouse operation. This pipe is a highly visible feature of the plant, and people have likened it to "a great big didjeridoo" and concluded that it may be the source of the low rumble. My observations would suggest that is not the case.

Dust

There was some localised black dust visible from the handling of charcoal fines with a front end loader, but generally the site was not dusty. The company has commenced a landscaping programme to improve the visual impact of the site.

There was no visible dust coming from the baghouse while I was there. The company had intended selling the silica fume for use in concrete but had not done so to date because the carbon content was too high. The planned backup pelletising had not been installed. Instead water was added to the fume to form a sludge which was being buried in an approved local tipping site.

Tinderbox West and Howden

Following my visit to the plant I returned to the area alone. I visited Patsy and Fritz Harmsen at Tinderbox West. Fritz is a musician and Patsy clearly enjoys their bush hideaway. Their sensitivity to noise is likely to be higher than that of the average person.

They used to live in Howden, and were accustomed to the noise of the old Carbide plant which occupied the Electrona site. That plant had a furnace which produced a low rumble that was sometimes disturbing, but did not have a baghouse.

They find the noise from the new silicon smelter more disturbing. At first their reaction on occasions when the noise troubled them was to pack up their tents and leave. Now if they are really troubled they take a drive into town. Patsy said she supposed that eventually one could get used to it, but they clearly feel that they should not have to.

The noise they describe is a low thumping. They acknowledge that the company and officers of the DOE have so far been unable to locate any noise source at the plant which might be responsible for the sound they hear. While I was there, there was a light breeze blowing towards the plant, and neither Patsy nor I could detect any sound coming from the plant.

I then visited Howden, and stood on the shore looking across at the plant. It was about 8:00 pm, and the breeze had dropped, but still there was no sound from the plant that I could detect.

Electrona
Continuing on, I visited the houses and monitoring station immediately to the north of the plant. These houses are owned by the company. The plant was just 270 metres away across a small valley, and the noise was quite obvious. While I was taking photographs of the plant and the monitoring station a boy about 9 years old came out of one of the houses and started talking. I told him what I was doing, and he said "It sure is noisy." I asked "Does it keep you awake at night?" and he smiled and said "No."

Snug
The town of Snug is south of the plant, on the shore of the bay, with a small sandy beach. Between Snug and the plantsite are first (from Snug) the recreation ground, then a stream, then, across a small footbridge, some high rocky ground bearing trees and bush running up to the plant boundary. The high ground forms a small rocky headland, and protects Snug from much of the noise, both from land and across the water despite the town's closeness to the site.

Connington, further around the bay, I did not visit. However the headland which protects Snug would not stop sound reaching Connington.

Dr Wnekowski
Following my visit to Snug I returned to Hobart and called on Dr. Wnekowski who had written a review of the literature on the health risks associated with silica fume while working as a general practitioner near to the plant site. The Doctor no longer works in the area, and has not done any further study on the subject.

She told me that she was not aware of any new information to change her opinion that from a public health point of view there was sufficient doubt about silica fume to justify it being treated with caution.

General Observations

It seems to me that the well-publicised problems of the Electrona smelter stem from these main sources:-

. there are houses too close to the plant site;

. the plant is at the water's edge;

. the plant is very visible;

. the company's public relations with the local communities;

. some of the affected residents are both exceptionally sensitive and eloquent;

. the company's internal structure as a joint venture with language differences making communication less easy has not helped;

. people were used to the old carbide plant which, though quieter would be unacceptable today as it had no baghouse to trap the dust; and

. people lacked faith that the goodwill of the company and the power of the DOE were sufficient to ensure that their environment was properly protected.

None of these applies directly to the Picton proposal, but there are some important parallels and some lessons to be learnt for all environmental assessments and the successful and harmonious development of industry.

Firstly, the Environmental Protection Authority (EPA)needs to have and to be seen to have strong powers to stop companies from degrading the environment. I believe that the Authority has those powers, but many of the public still need to be convinced of it.

Secondly, I think it is essential for the successful and harmonious operation of a major industrial plant that there is established some formal communication between the company and the residents whose environment is affected by its operation. If there were a committee of residents dealing directly with the company (with the EPA acting as umpire if necessary) it could go a long way to restoring the feelings of trust and control which some residents seem currently to lack.

Thirdly, while it may well be possible to operate a silicon smelter in an environmentally acceptable manner with houses as little as 200 metres away, it is likely to be easier to manage if it is located further from residential development.

3. BELL BAY FERROSILICON SMELTER

On my second day in Tasmania I travelled with Bob Chesterman of DOE to Bell Bay on the northern coast near Launceston where Temco, a subsidiary of BHP operate a ferrosilicon smelter. The method of operation is closely related to that of silicon smelters, and it was considered that useful comparisons could be made.

Temco's plant includes three other furnaces used for the production of ferromanganese, and has been operating in the area for many years. Over the road is a large aluminium smelter owned by Comalco. The whole industrial area is surrounded by a large buffer zone of uncleared scrubland, and the main workforce resides in George Town, six kilometres away at the mouth of the Tamar River.

The ferrosilicon smelter is some thirteen years old now and is due for some refurbishment, and Deputy Manager Terry Howard and Mark Fontana who supervises the operation of the smelter assured me I was not seeing it at its best.

Certainly in the baghose and the furnace building there was thirteen years' accumulation of dust on the floor, but the atmosphere did not look dusty, and it did not cause me any discomfort, even in the baghouse as it was operating. It was hot in the baghouse, but I was told that it was possible to do routine maintainence "on the run" by closing down just a section rather than the whole baghouse, thereby reducing the need for direct venting.

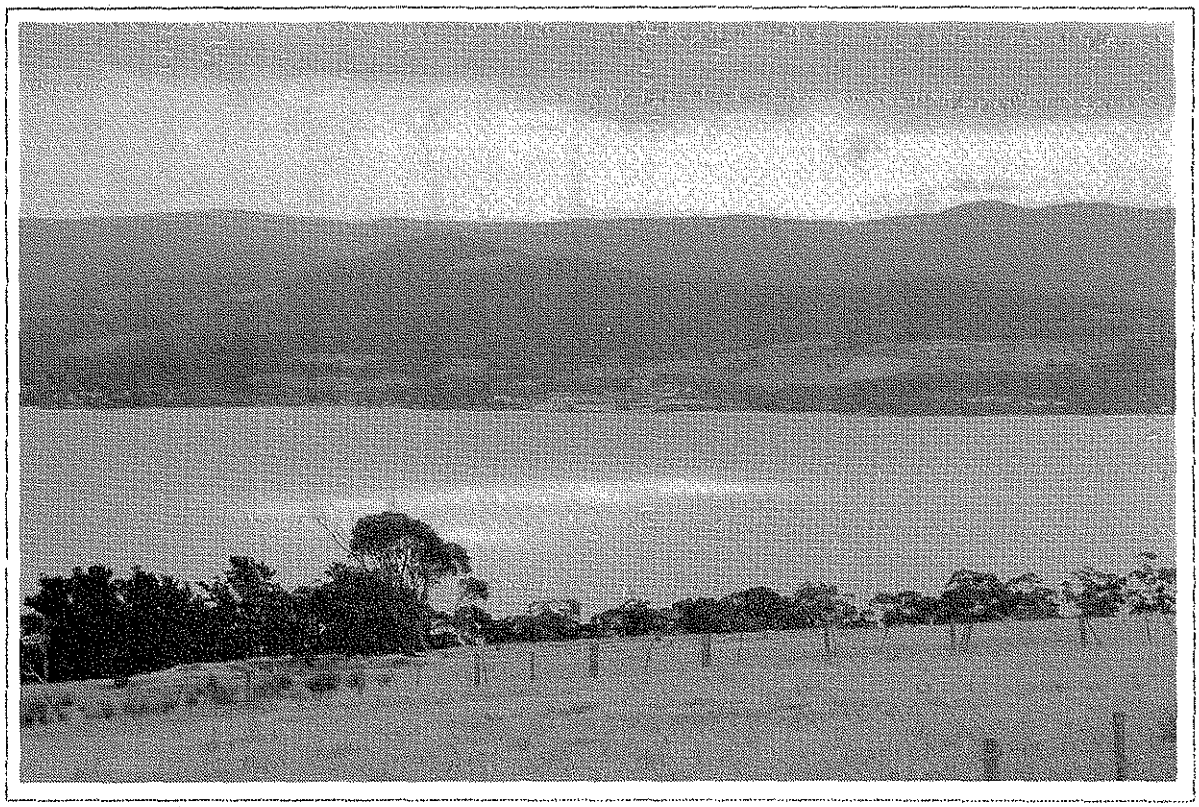
The collected fume is pelletised and where possible sold to the concrete industry, although that market is still developing. About 50% is sold locally, and there is some interest in Japan. Some was sold to one of the North West Cape developments. Another possibility being investigated is to combine it with other waste products from the plant to produce a soil.

The plant is so set up that if a major fault develops in the baghouse, it trips a control to commence direct venting and automatically cuts the furnace to minimum power. This keeps the 'melt' molten and reduces the emissions. Normally the fault would be rectified as quickly as possible, and the furnace would be returned to full power after 15 minutes.

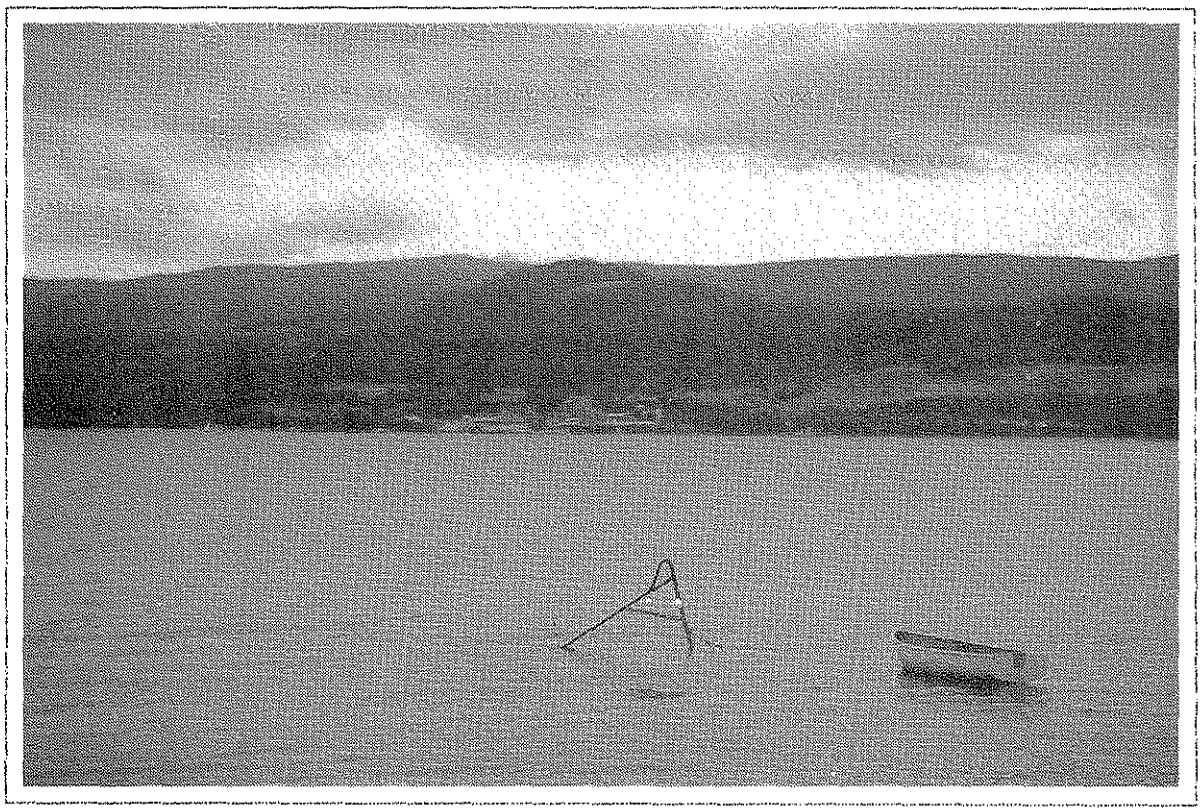
Should a more serious problem arise, it is possible to turn off the furnace for up to 8 hours with little difficulty apart from the loss of production. Beyond that it is very likely that one of the electrodes will break. They have successfully restarted after a three-day shut down, but it is a risky business from the company's point of view. If the furnace freezes up it costs millions of dollars to dig it out and weeks of production are lost.

The plant site is large, with twice as many furnaces as are proposed for Picton. The dustiest operation and according to Temco's measurements the noisiest is the operation of front end loaders in the stockpile area. I did not notice any dust surpression equipment, though there could well have been some. The manganese ore which produced black dust when handled would not be a part of the Picton proposal.

BHP desires to be a good corporate citizen, and is continually improving its environmental impact. Of course it is true that to some extent its previous profitable operation under less stringent environmental requirements has enabled the company to afford the improvements. Any new development is required to meet the more stringent requirements immediately, which obviously places it at a disadvantage to its established competitors.

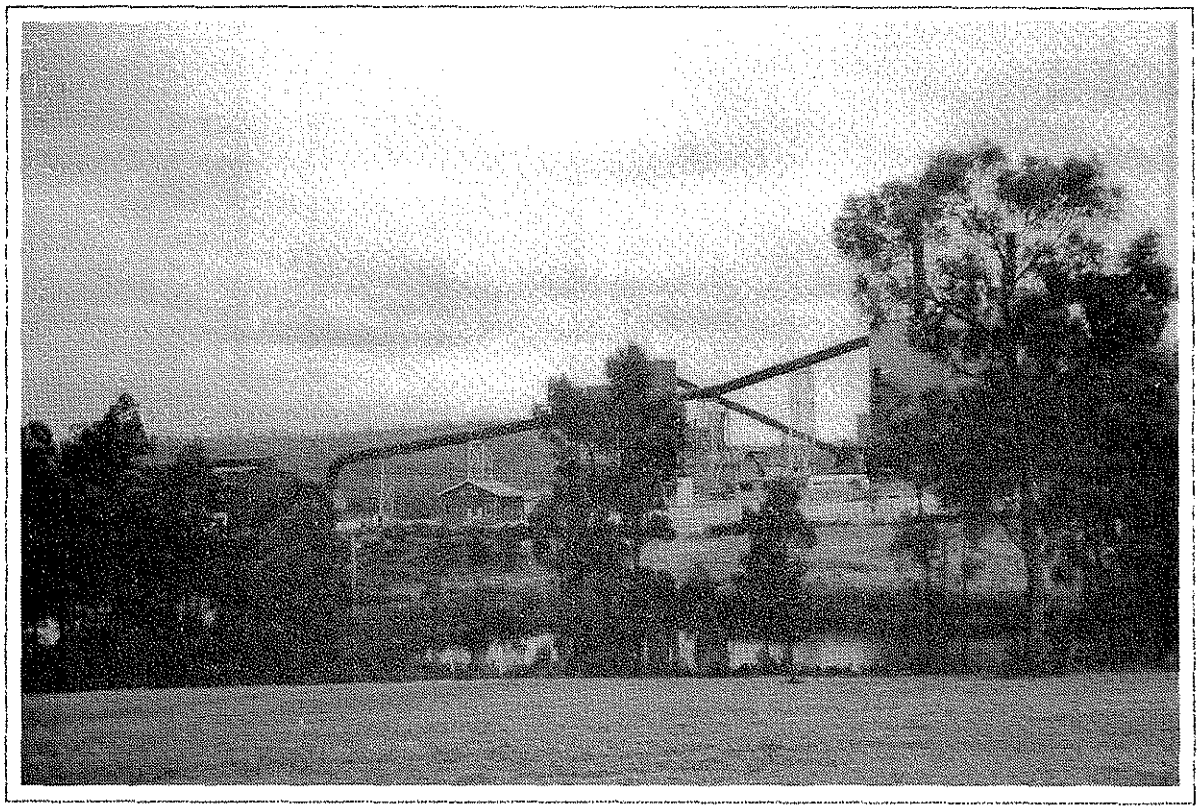


1. Electrona from the Tinderbox West Road. The plant is in the centre of the picture, at the water's edge.

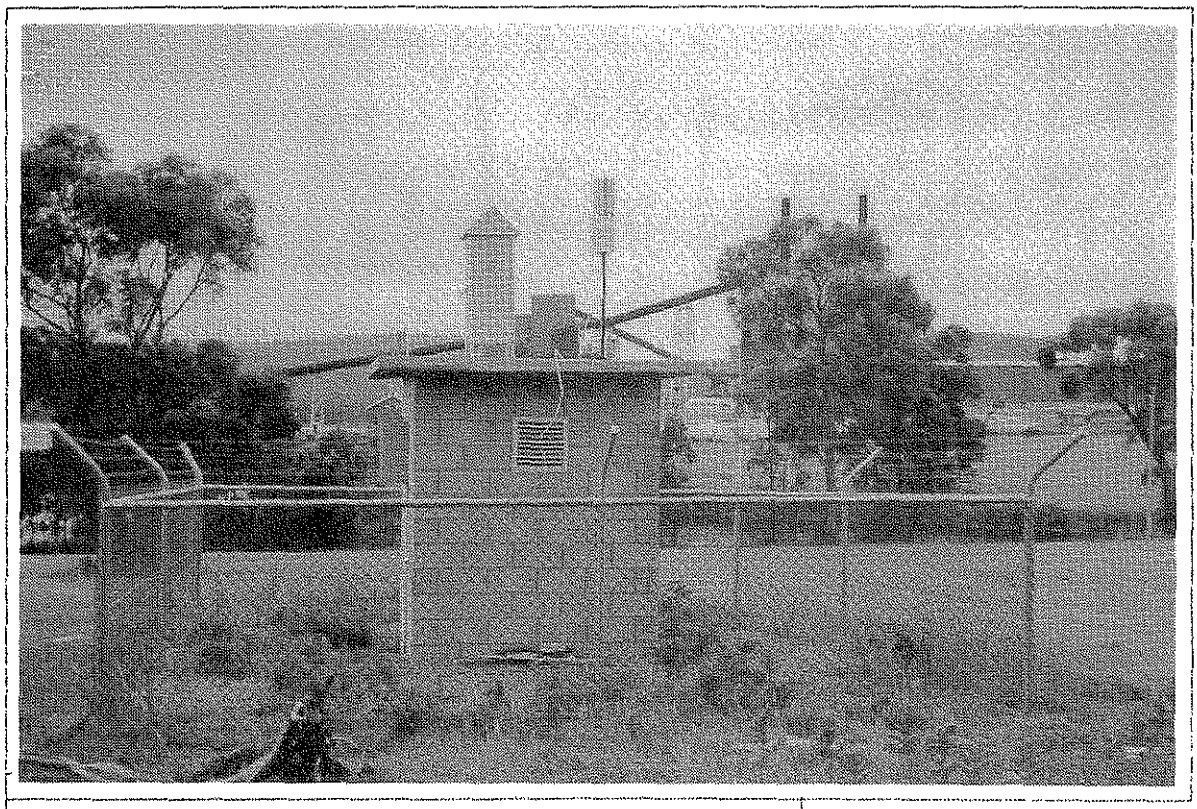


2. Electrona from the shore at Harmsen's place, Tinderbox West.

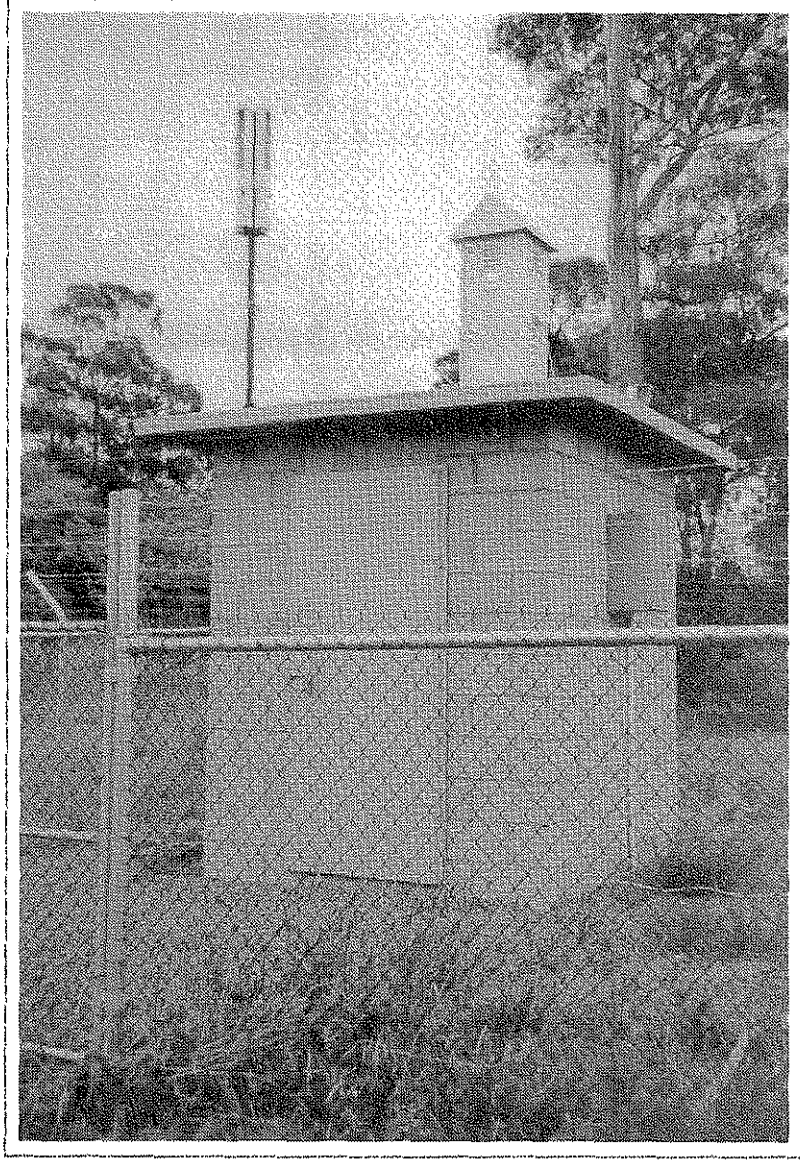
3. Electrona from the shore at Howden



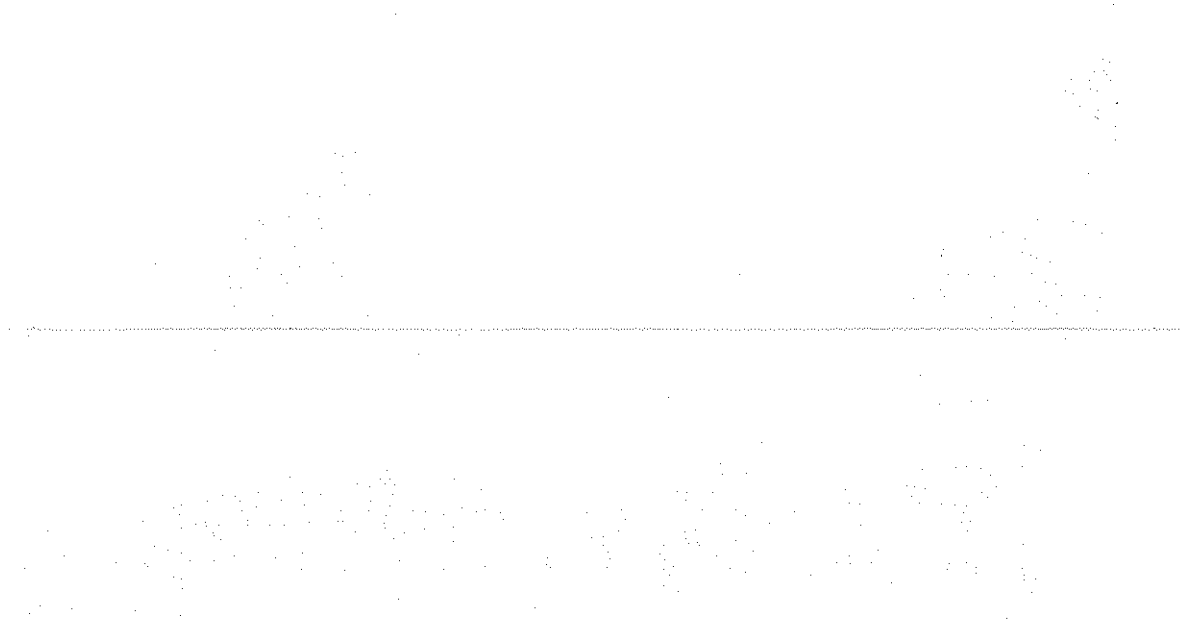
4. View of the plant showing the furnace house and ducting to the baghouse on the left of the picture.

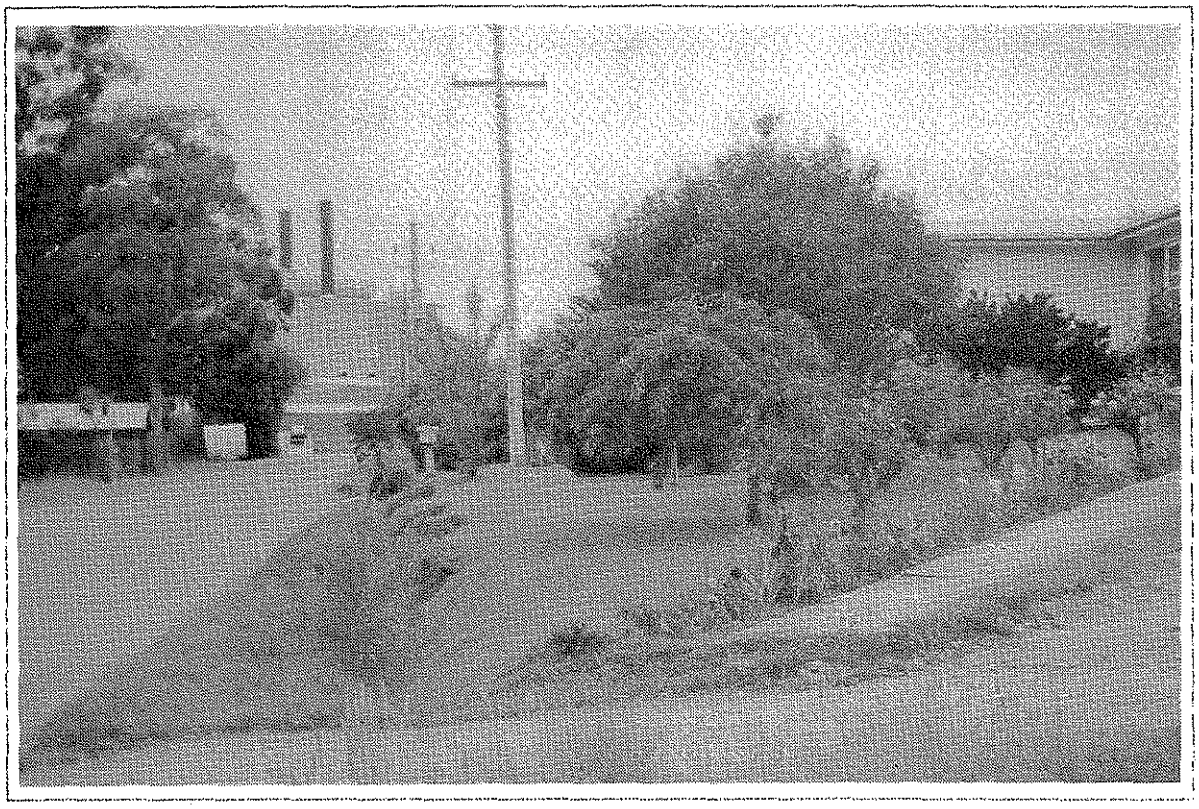


5. Monitoring station at Electrona, 270 metres North of the plant. Photograph 4 was taken from in front of this station.

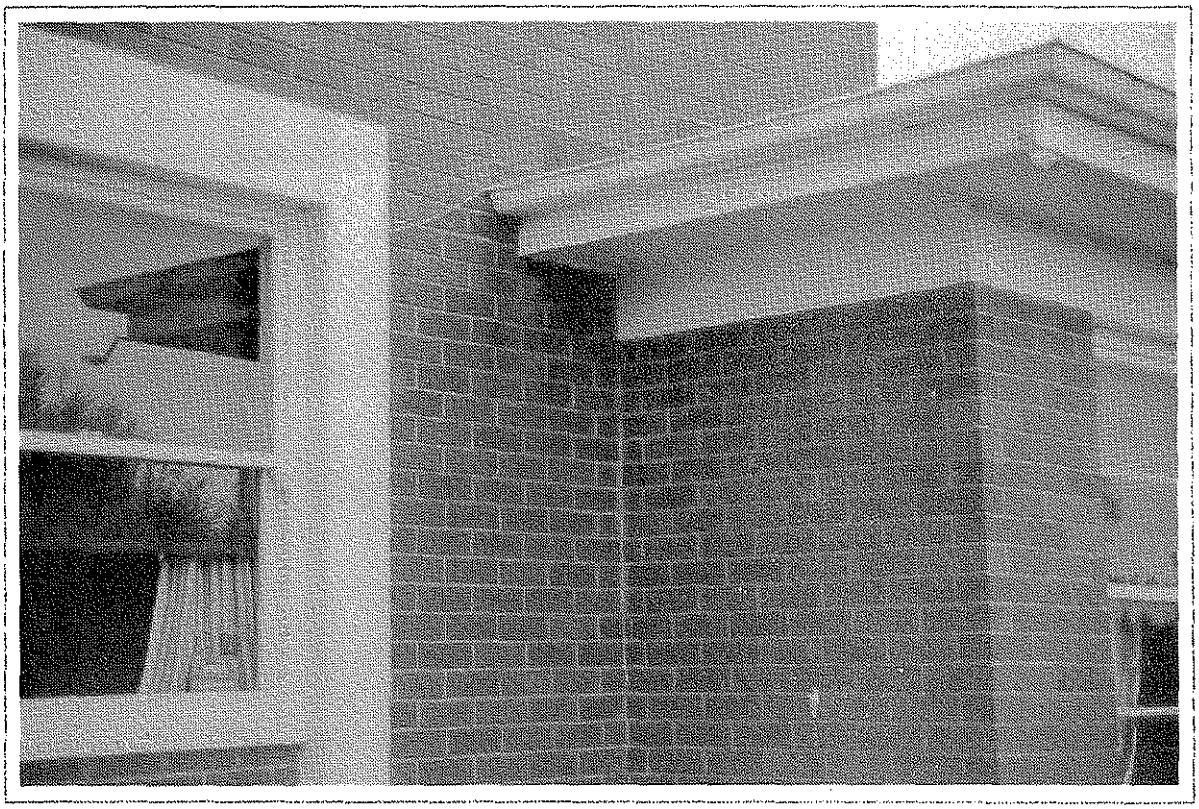


6. Close-up of Electrona monitoring station, erected and maintained by the Company which reports results to DOE.

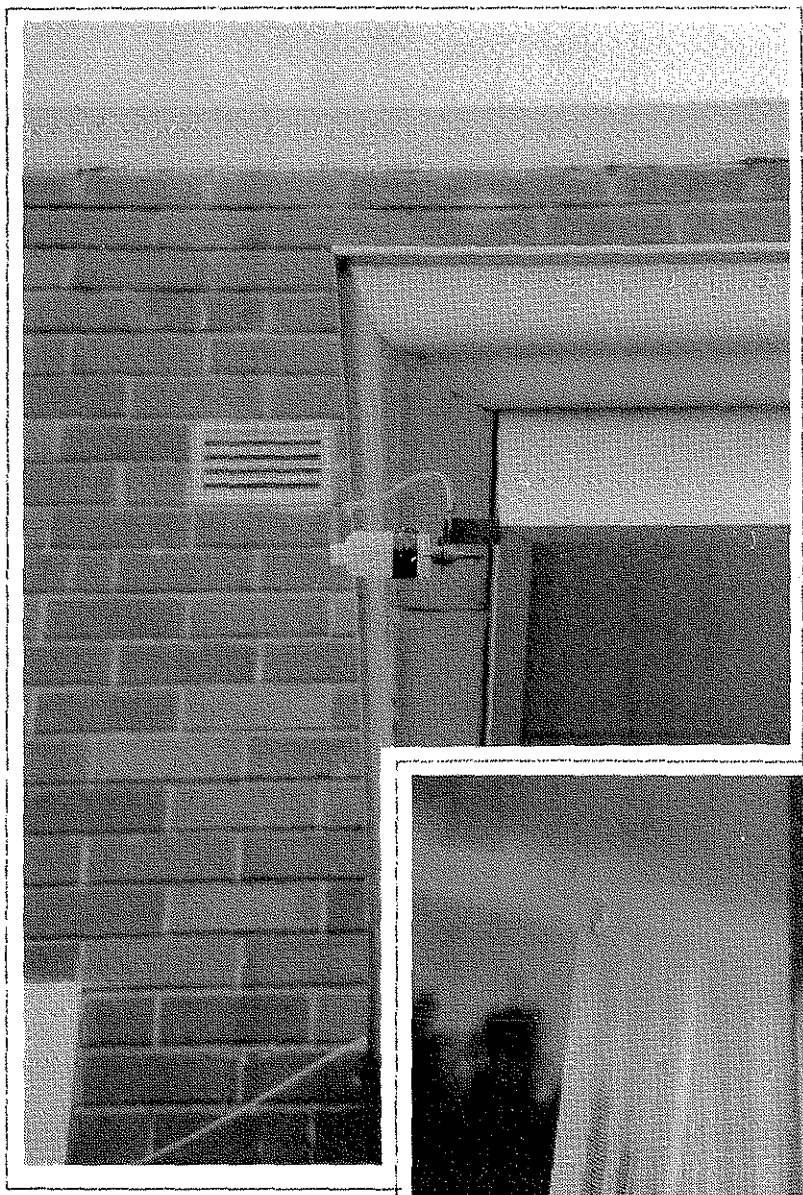




7. A row of Company houses along the road leading to the plant site. The closest house is less than 200 m from the plant



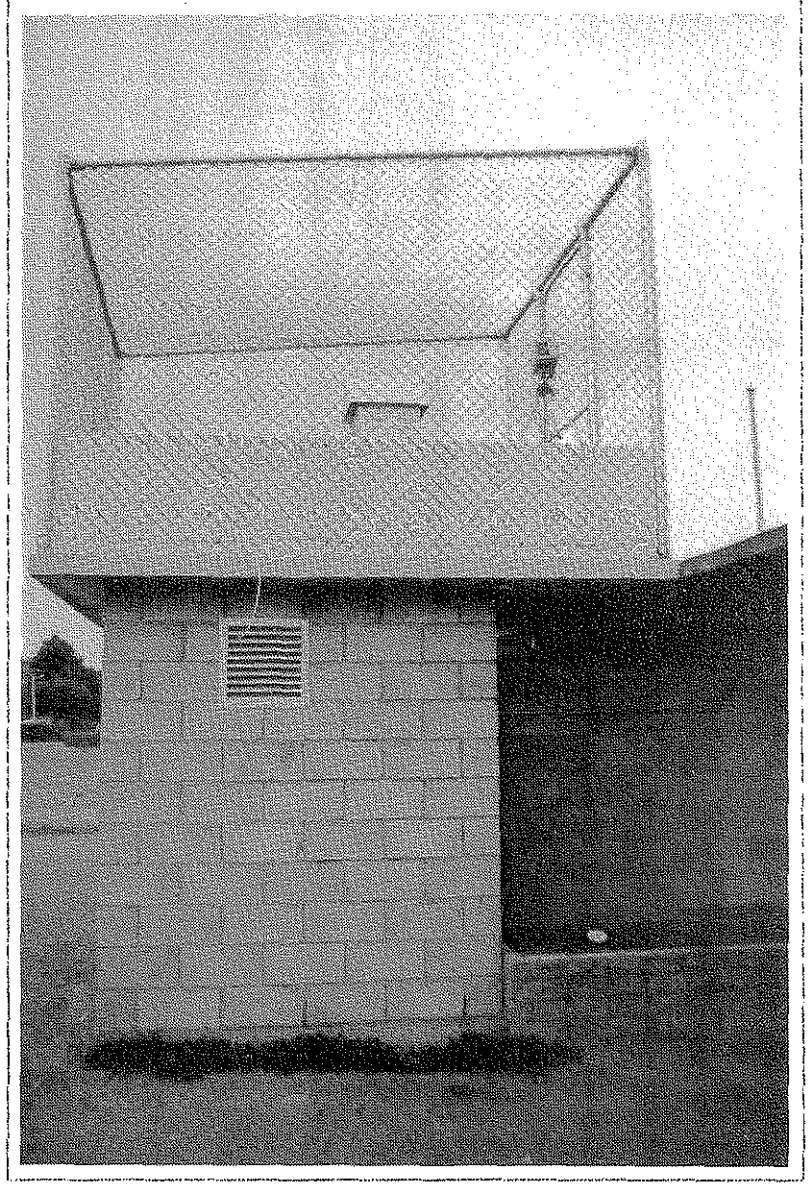
8. The low volume dust sampling unit installed and operated by DOE at Snug Primary School, 1.2 km from the plant.



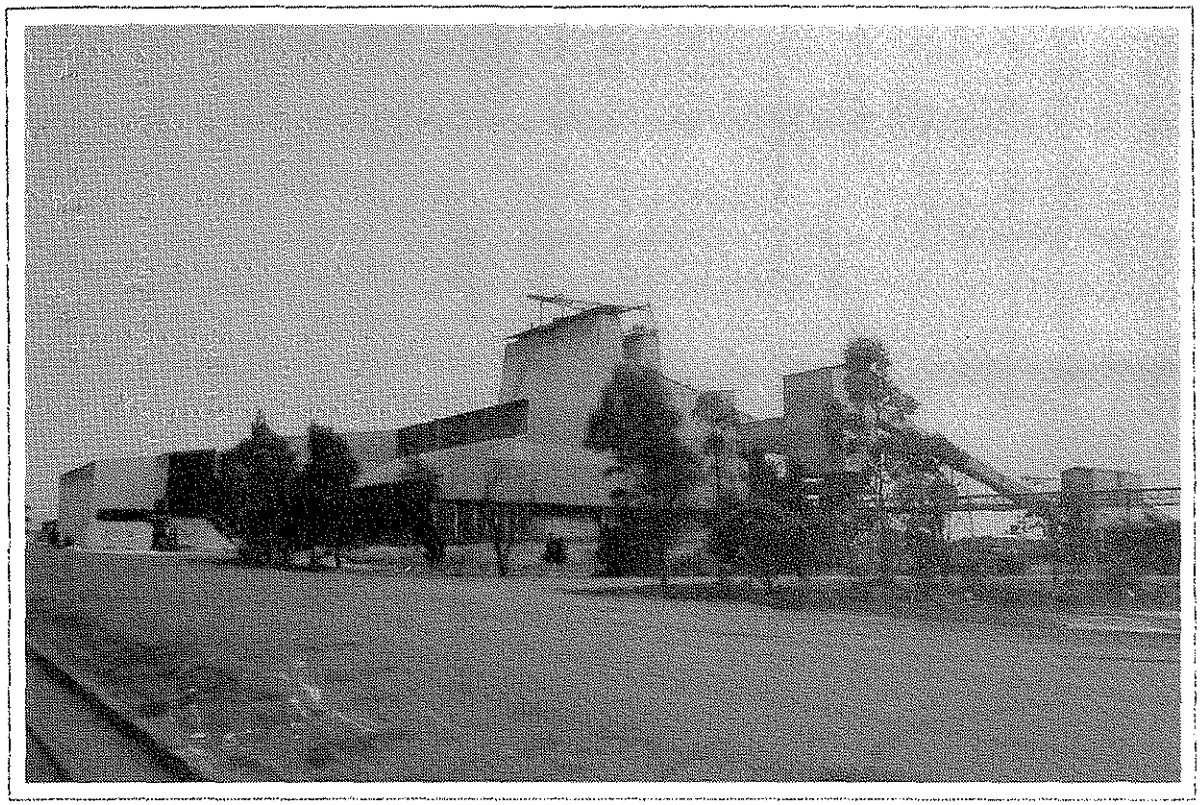
9. Close-up of the filter unit of the low volume dust sampler, attached to the gutter of Snug Primary School.

10. Close-up of the pump unit of the low volume sampler in the Headmaster's office, Snug Primary School.

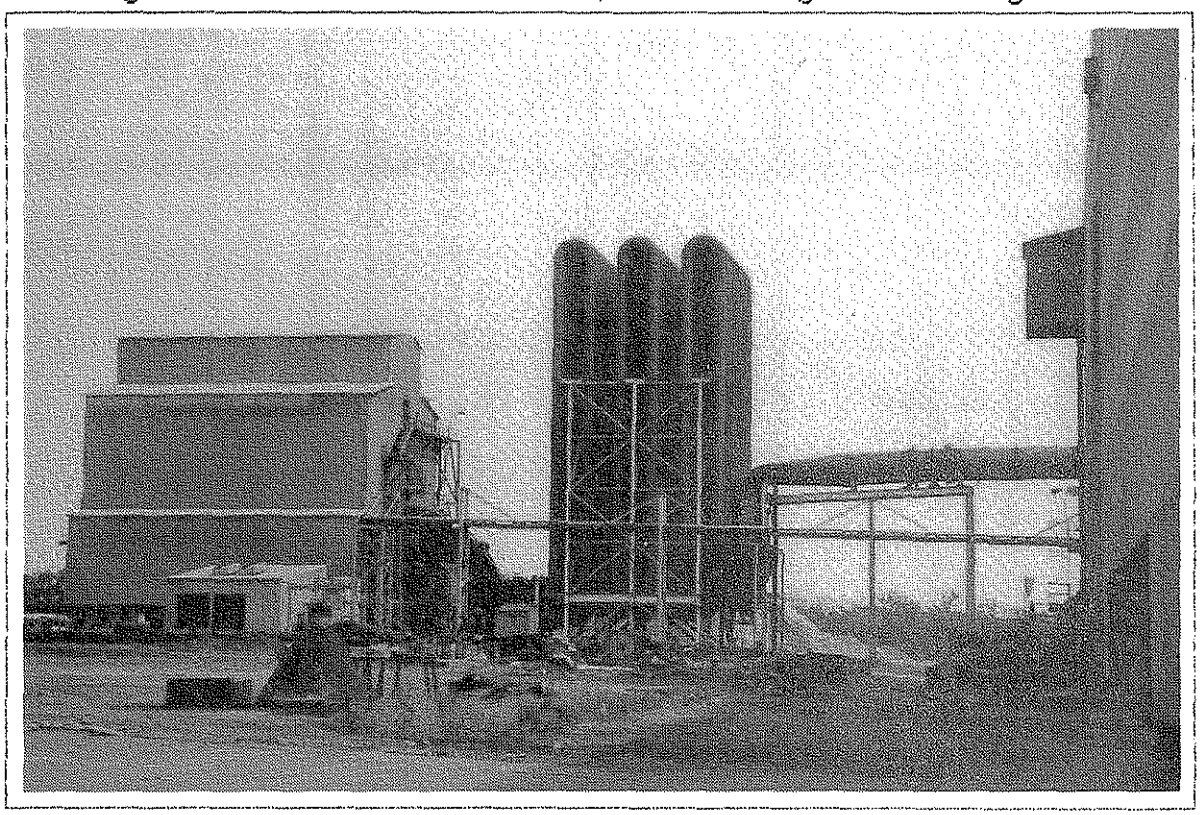
11. View from the Company's Snug monitoring unit, across the recreation ground to the plant, behind the wooded ridge.



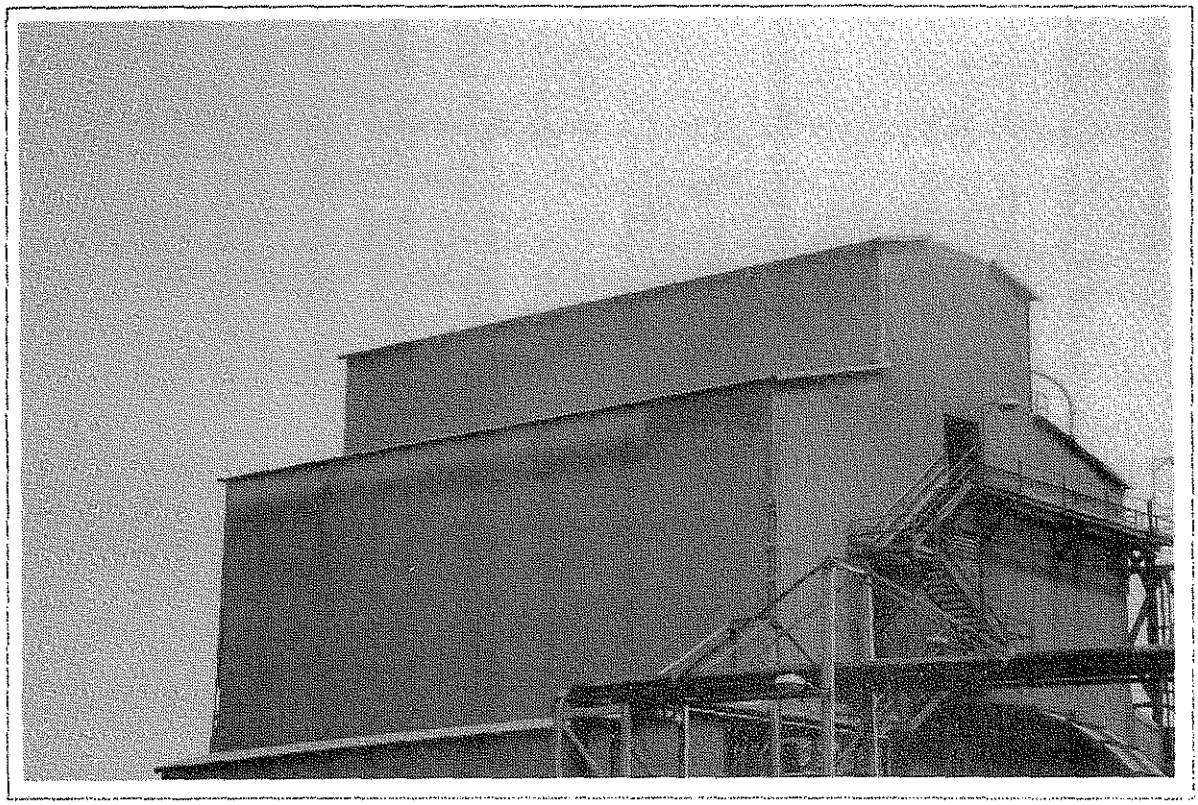
12. Close up of the Snug monitoring unit showing the DOE 16 mm time lapse camera trained on the furnace vents.



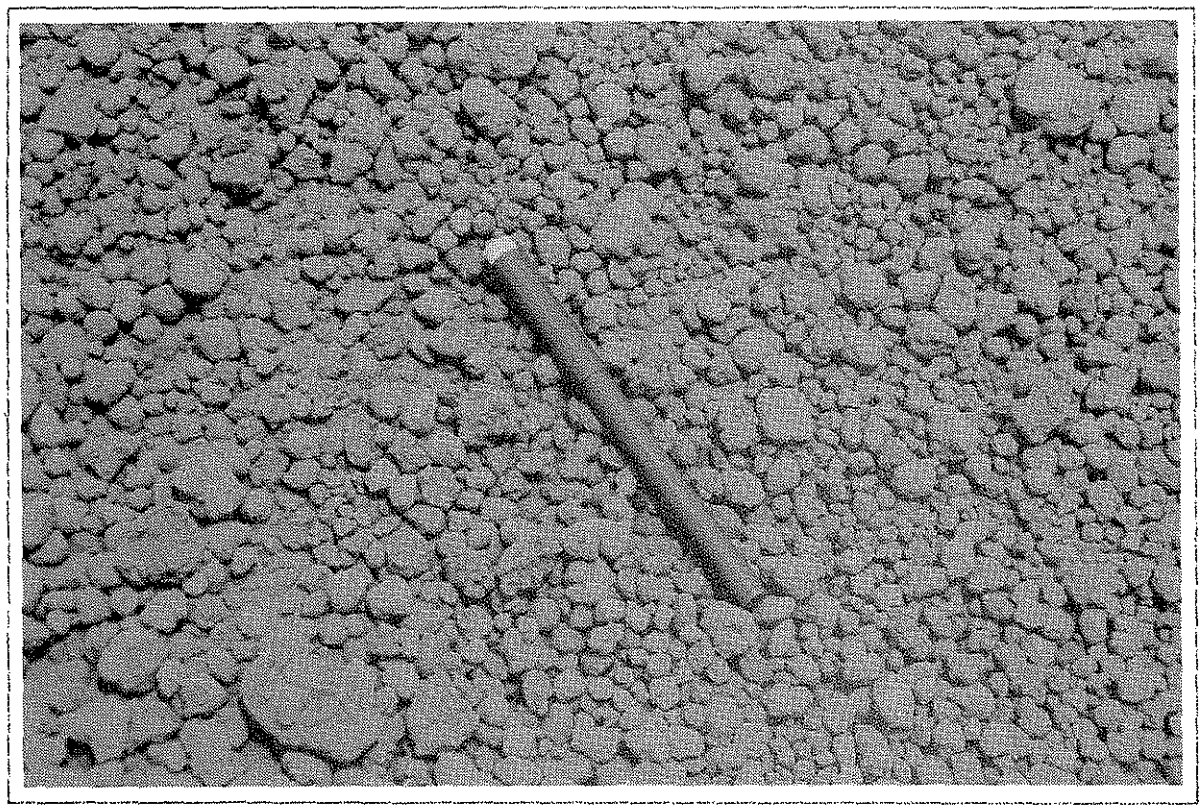
13. View of the Temco ferrosilicon smelter at Bell Bay. The enclosed conveyors on the right carry the raw materials. The furnace is in the centre, and product handling to the left. The baghouse is behind the furnace, obscured by the buildings.



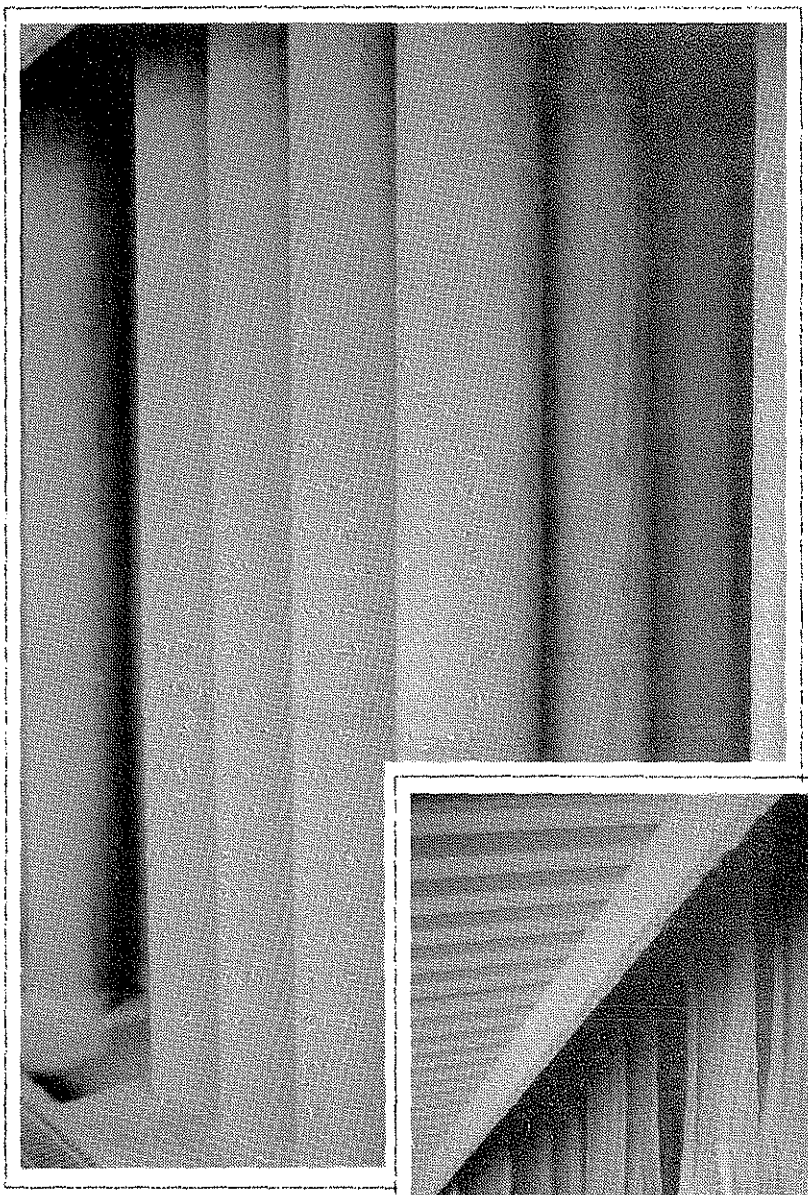
14. Behind the furnace building are the serpentine gas cooler and baghouse. A modern baghouse of similar capacity would be much smaller, and may well use a different sort of cooler.



15. Close-up of baghouse roof, showing slight whisps of fume escaping from roof vents. Management regarded this as excessive.



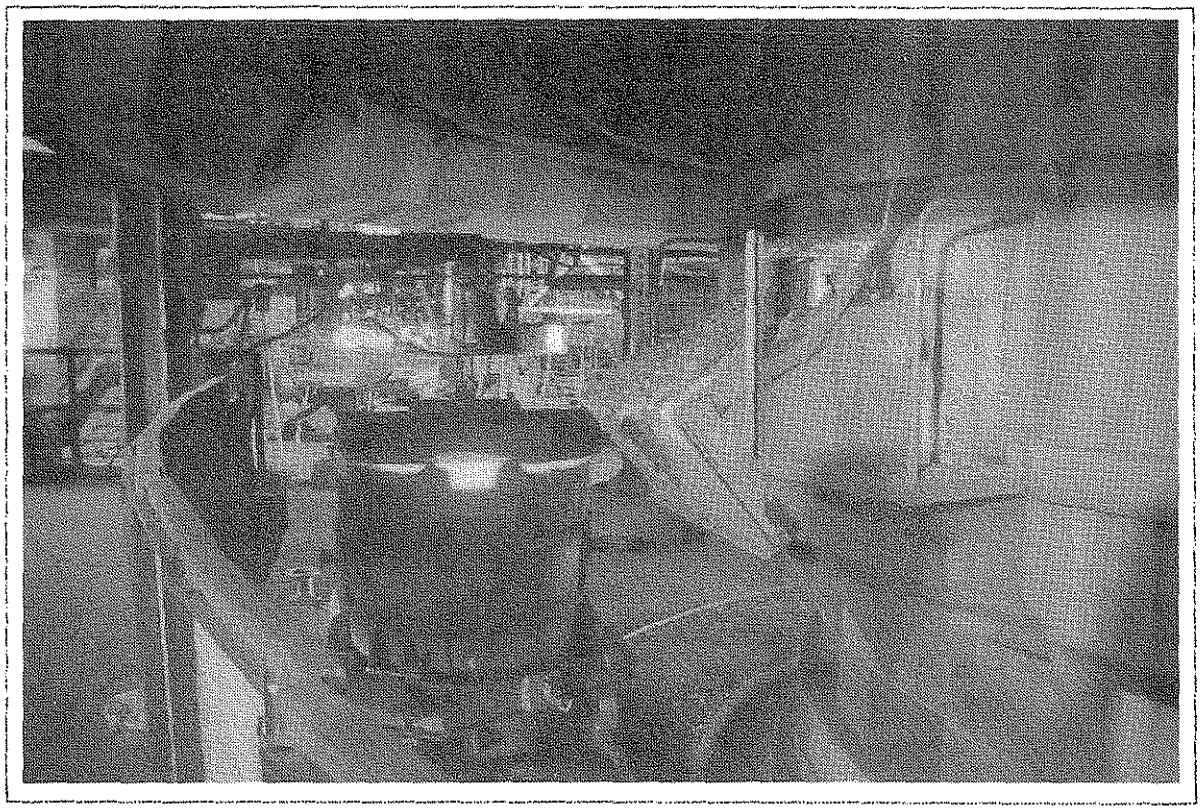
16. Pelletised silica fume.



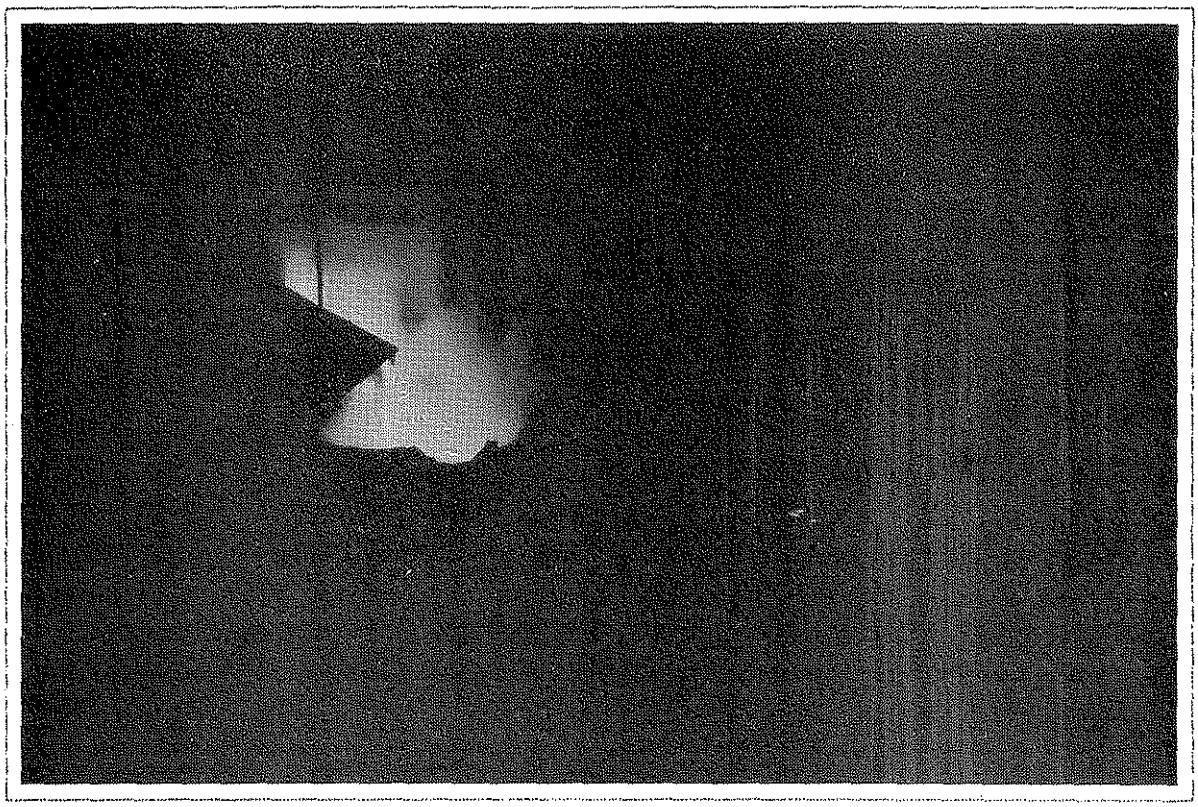
17. View inside the baghouse, showing bags operating normally. Sections can be isolated for bag replacement and maintenance without stopping the baghouse.

18. Bags during reverse pulse cycle. At this time dust is dislodged from the insides of the bags and falls to the bottom, where it is collected.

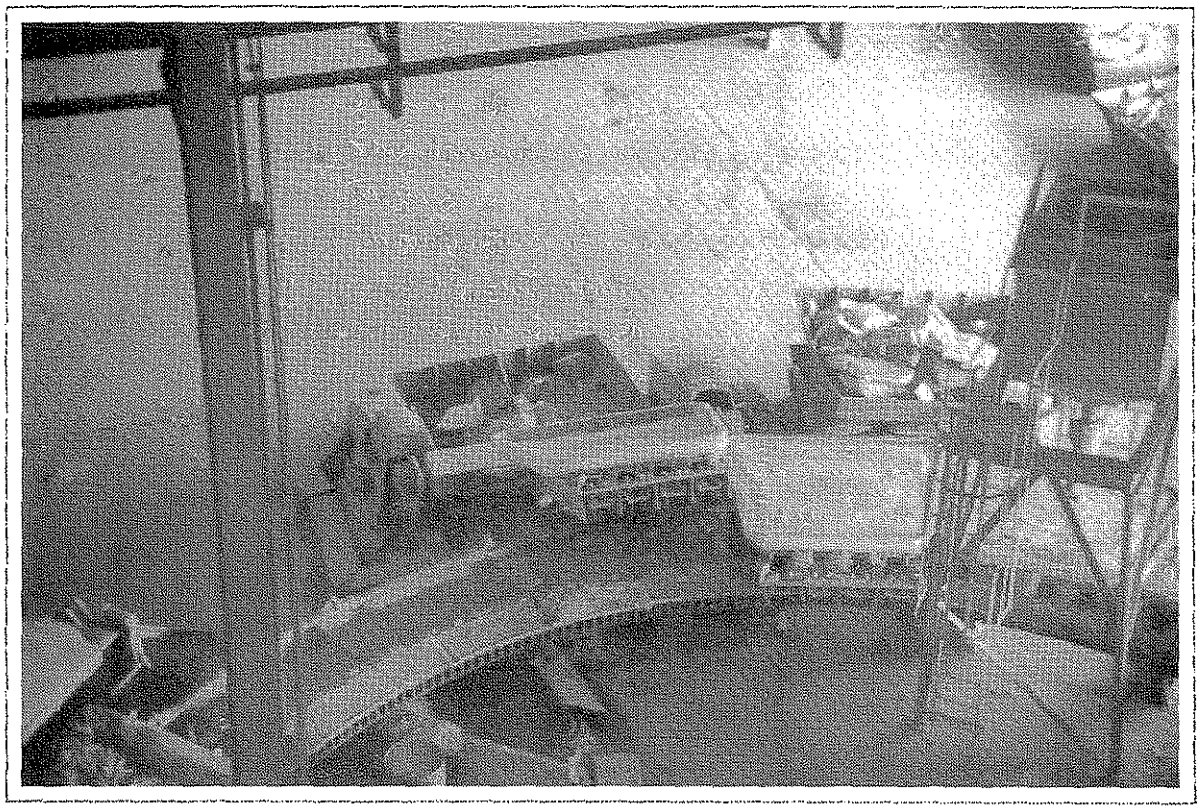
19. View through the furnace stoking hole, showing piles of raw materials ready for stoking. Note how dust is drawn into the furnace hood by the flow of air.



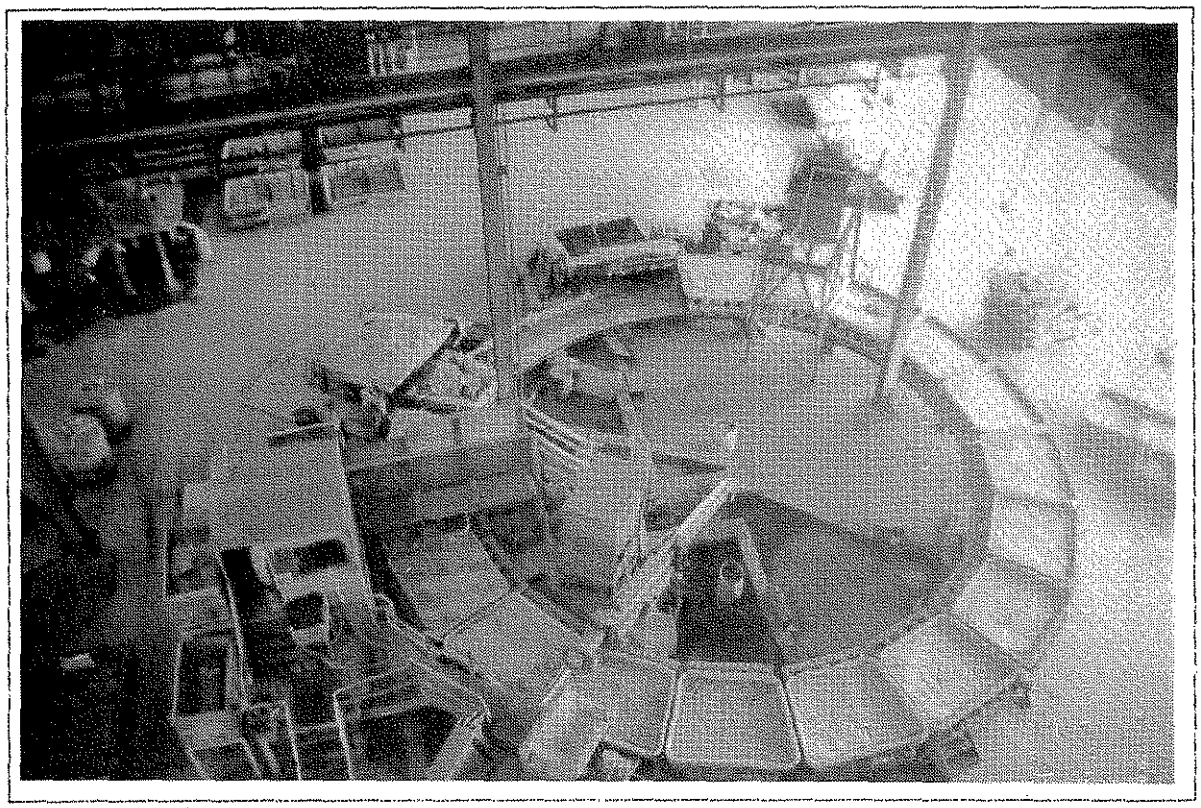
20. A ladle being pre-heated ready for tapping. Just right of centre is one of the furnace tapholes which is plugged.



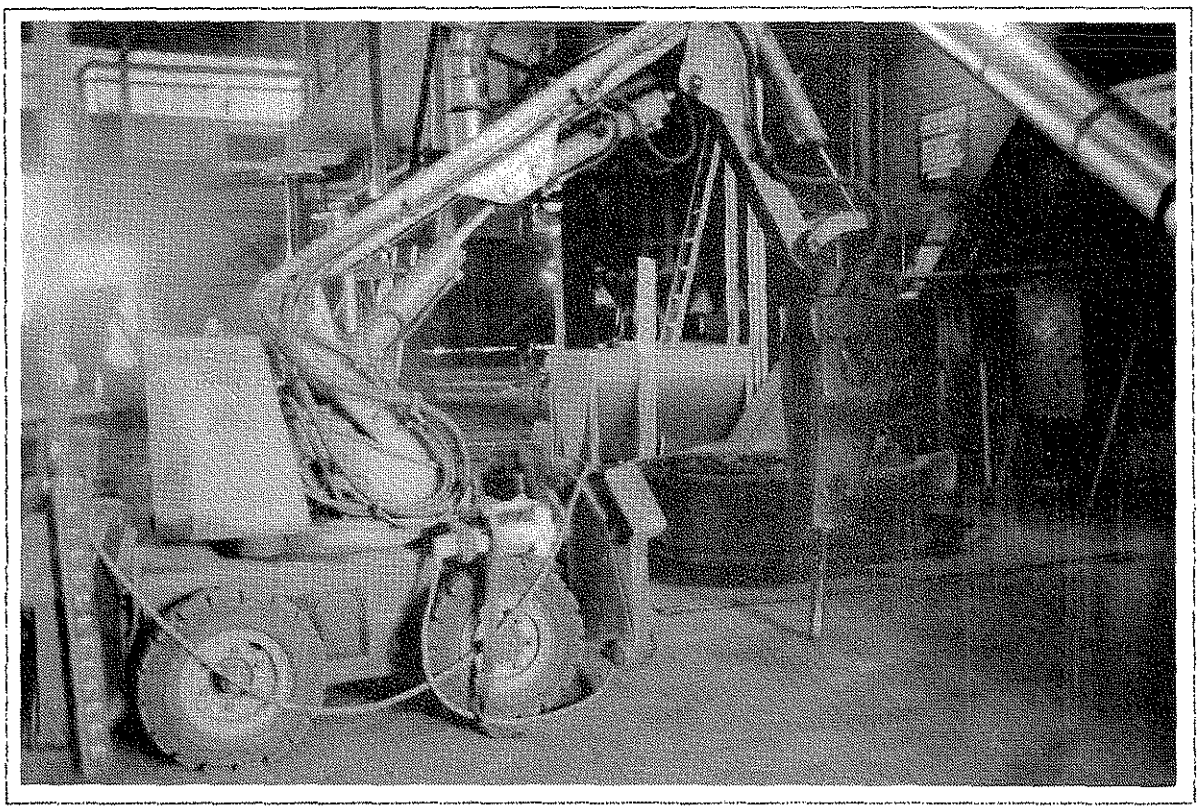
21. Tapping the furnace.



22. Tipping the ingot from the mould into the skip while still red hot shatters it into large chunks.

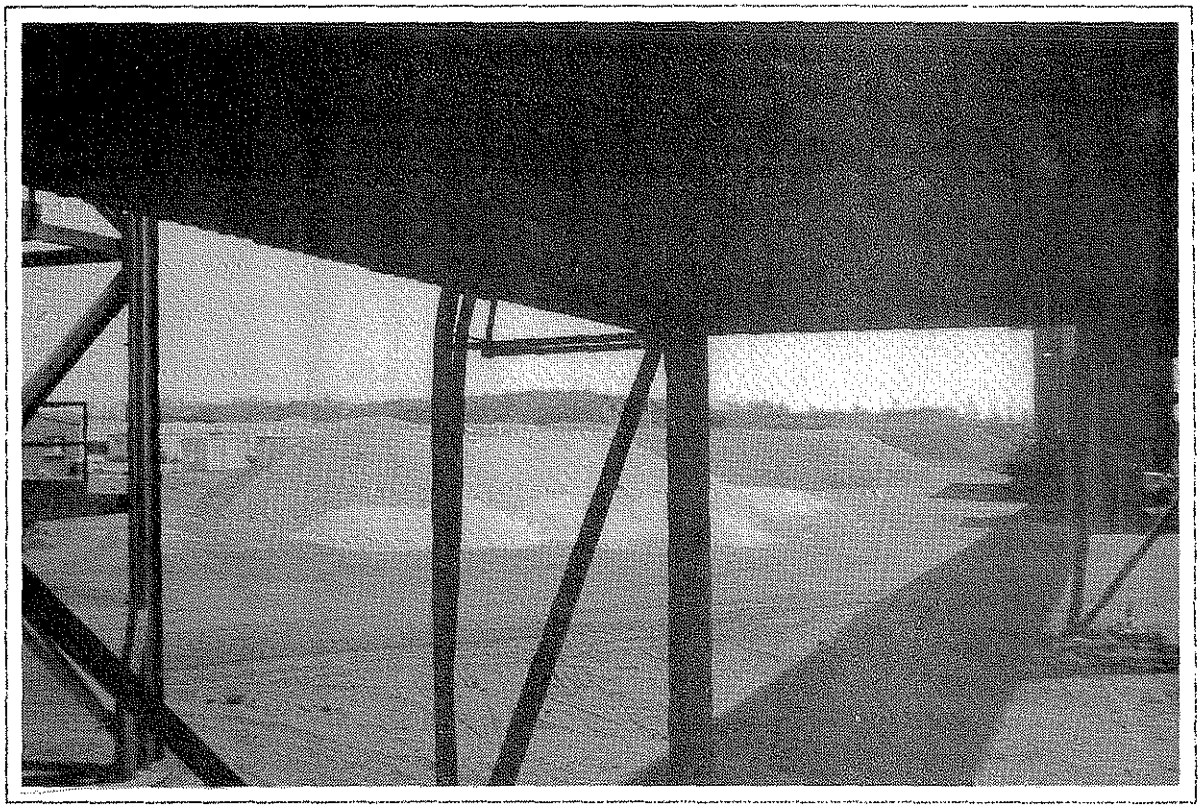


23. General view of the rotary ingot pouring and tipping unit.



24. Specialised machine used for ladle cleaning.

25. Ferrosilicon product stockpiles and specialised closed containers for transport (silicon does not require these containers).



26. Raw materials stockpiles. In the background are slag heaps from the ferromanganese smelters on the same site. The silicon smelter produces no slag.

APPENDIX G

ENVIRONMENTAL MANAGEMENT COMMITMENTS BY THE PROPONENT

BARRACK SILICON PROJECT

ENVIRONMENTAL COMMITMENTS

MARCH 1988

1.0 PREAMBLE

Barrack Silicon Pty Ltd as proponent for the Barrack Silicon Project to be located at Picton undertakes to make various environmental commitments in relation to the project. This document outlines those commitments.

2.0 PUBLIC ENVIRONMENTAL REPORT

The proponent engaged consultants Maunsell & Partners to prepare a Public Environmental Report, dated November 1987. That report should be read in conjunction with this document.

3.0 ENVIRONMENTAL COMMITMENTS

3.1 Picton Site - General

3.2 Quartzite Supply

3.3 Wood Supply

3.4 Charcoal Production

3.5 Silicon Production

4.0 ATTACHMENTS

4.1 1:2000 General Arrangement

4.2 Wood Transport Corridors Figure 6.2

BARRACK SILICON PROJECT COMMITMENTS

3.1 PICTON SITE GENERAL

3.1.1 The proponent is committed to being a good corporate citizen and to complying with reasonable and justifiable EPA requirements, but in particular to the two main environmental issues of the project, dust emission and noise control.

3.1.2 Within the plant site the proponent is committed to the selective clearing of trees as indicated on the site GENERAL ARRANGEMENT drawing number 100-G-002 and the following extract from the earthworks specification.

"The Contractor shall give the Project Manager seven (7) days written notice of the intention to clear any "bush" from reserves so that the Project Manager may inspect the Site and determine which trees within the limit of clearing are to be preserved, and which are to be removed. No clearing shall commence until the Project Manager has indicated which trees are to be preserved."

3.1.3 It is the intention of the proponent to undertake an ongoing responsibility to improve landscaping and screening of the site within practicable and economic limits. Initially a 25 metre band of trees/shrubs will be planted adjacent to South-West Highway selection of species subject to the variability of the surficial water salinity. Careful selection of indigenous species will be undertaken.

3.1.4 The proponent has a licence from the Western Australian Water Authority (WAWA) to draw up to 1000 m^3/day of ground water from the "Leederville" aquifer and is committed to monitor/test bore water as required by WAWA. Adoption of a closed circuit water cooling circuits in the silicon process greatly help to conserve water usage. The proponent will optimize usage of plant water to its fullest practical extent.

3.1.5 In the event that runoff water is required to be treated, application will be made with EPA prior to discharge into nearby water courses. As appropriate the local authority and WAWA will be consulted should existing drains be used.

3.1.6 The wood stockpile and the plant site in general has a ground level graded to drainage falls into surface drains which in turn are routed to a stormwater sedimentation pond at the South Western corner of the Site designed to cater for a one in five year return period storm. Any overflow from this pond will flow into existing drains subject to application to EPA and availability determined by the local authority and/or WAWA.

3.1.7 The proponent is committed to the installation and maintenance of a first-aid vehicle, a fire tender, appropriate trained personnel and developing safety and contingency planning both during construction and operation of the project. Application annually will be made to the Minister for Emergency Services through the Bush Fires Board of Western Australia to operate fire risk areas of the plant during the high risk summer months of November through to March.

3.1.8 The proponent will develop a comprehensive air emission and atmospheric monitoring programme in consultation with the EPA, to establish the environmental impacts from the project's operation.

3.1.9 The proponent, in addition to seeking practicable and economic methods to consistently reduce noise emissions at their source, will routinely monitor the efficiency of silencers and noise attenuation equipment and will take remedial actions where necessary to maintain efficiency of same.

3.1.11 Solid wastes will be carefully monitored to maximise recycling and resale wherever possible. Solids requiring disposal will be collected and transported to an approved landfill and will be subject to control by EPA.

3.2 QUARTZITE SUPPLY

3.2.1 Quarrying operations will be managed to ensure minimum practicable noise disturbance to the surrounding environment and to that end quarrying operations will generally be restricted to the hours of 0600 to 1700 Monday to Friday, during annual mining campaigns not expected to exceed three to five months each year.

3.2.2 The contract quarry operators will be required to implement appropriate blasting techniques to achieve a maximum 115 dB peak linear limit. This may include the use of sequential timers or alternative approved methods of blast initiation.

3.2.3 Blasting activities will not proceed during periods when wind conditions would result in the transport of significant dust from such blasting operations towards the nearby vicinity of neighbouring farms.

3.2.4 With the exception of the first year of operations when the delayed timetable for the Project may necessitate a summer/autumn mining campaign, quarrying operations will be scheduled for the period mid August through mid-December when post winter moist soil conditions should assist in dust suppression and dust control around the mine site.

3.2.5 The proponent is committed to mine site rehabilitation in accordance with the requirements of the Department of Mines. This plan will include rehabilitation where practicable using local native vegetation. In addition the proponent will seek advice from CALM on the management of Regelia megacephala populations, including the practicality of establishing trial experimental plots to determine criteria for successful regrowth. Where there is a risk of direct impact of mining or service equipment on populations of Regelia megacephela these populations will be fenced off.

3.2.6 Haul roads will be selectively routed by the proponent to provide minimum disturbance to the environment. Dust suppression by water spray on haul roads and at the crushing plant will be implemented should significant dust occur. Tree-planting for screening purposes will be undertaken, in consultation with the farmer/landowner, where necessary and practicable.

3.2.7 Mining operations will leave some areas of inferior grade ore thereby preserving to some degree the visual amenity of the quartzite hills to the north of Moora.

3.2.8 Mining operations including drilling, excavating, quartz haulage and crushing and screening will include dust suppression and dust control measures designed to ensure compliance with occupational health statutes.

In particular drilling will be carried out by an airtrack drill fitted with a "filterclone" dust control system or similar, with separated dust being disposed of in accordance with the Mines Department requirements.

Fine mist water sprays will be installed at the receival hopper and crusher, and provision will be made to damp down muck piles, haulroads and stockpile areas to control fugitive dust.

3.2.9 Efforts will be made to recycle extracted waters to minimise water consumption where practicable.

3.3 WOOD SUPPLY

Wood supply to the Silicon Plant at Picton is a responsibility of the W.A. Department of Conservation and Land Management through its contract with the proponents to fall, extract, load, transport and deliver log timber onto the Picton site. The proponent will rely on CALM to meet its contractual obligations in relation to the following commitments.

3.3.1 Wood will be transported on 20m long articulated 70 tonne log haulage trucks. Proposed routes for the period 1989 - 1992 and for the period 1993 - 1998 are shown in Fig. 6.2. These routes are presently used by log haulage trucks.

Major transport corridors for the first 5 years would be along Pile Road, then Upper Ferguson Road, entering the South Western Highway near Dardanup.

3.3.2 Log haulage vehicles, immediately after entrance to the site, will be specifically diverted away from day to day traffic primarily for safety reasons. Timber will only be received at the plant site during daylight hours Monday to Friday, with possible extensions to Saturday if agreed between CALM and the proponents.

3.3.3 The proponent intends to purchase wood to produce charcoal from the Department of Conservation and Land Management (CALM) under the Government approved Department's General Working Plan No. 87. Wood deliveries by CALM will be contracted to be delivered directly to the Picton site. CALM has developed and is committed as is the proponent to the quarantine and hygiene procedures designed to minimize and reduce the risk of spreading jarrah dieback.

3.3.4 The proponent recognizes that the maintenance of flora and fauna within the State Forest is highly desirable. Currently there is no information on the use of tree hollows by fauna in the Jarrah forest so the proponent will fund and supervise with CALM a post graduate research project to evaluate these predictions and the effects of silvicultural practices specifically for the project. Information from this project will be made available to EPA within 3 years of the start of plant production.

3.3.5 If the research project detects any significant impact of the silicon project on fauna, wood collection operations will be more widely dispersed over the areas being cut for timber to reduce the effect subject to CALM approval. Alternatively some firewood trees and logs will be left in the forest to ensure niche retention.

3.3.6 The General Forest Working Plan No. 87 divides the forest into areas with different Management Priority Areas (MPA's). Subject to hygiene controls firewood extraction is permitted within MPA's however timber extraction from MPA's for recreation will not be carried out under this proposal.

3.3.7 Forest areas allocated to flora, fauna and landscape conservation are not available for timber extraction.

3.3.8 The proponent through CALM, is committed to the current silvicultural management practices for jarrah forests which will, wherever practicable, be enforced for wood produced for this project to provide optimal conditions for the growth of preferred young trees by reducing competition. The objective of the proponent is to ensure an economical supply of dry wood substance to the Project for the purposes of charcoal and silicon manufacture consistent with forest conservation through comprehensive long term strategy planning.

3.4 CHARCOAL PRODUCTION

3.4.1 The design of the overall docking mill complex is under review. The concept selected will incorporate systems designed to reduce noise levels in the vicinity of the complex, consistent with the proponents overall undertakings for control of noise as contained with the PER.

3.4.2 An incinerator will be incorporated by the proponent in the retort complex to combust volatile material in the rinse gas and pyroligneous vapour.

3.4.3 Retort loading arrangement consists of:

1) Upper retort door (swing gate design).
2) Lower retort door (slide gate design).

The system is designed to minimise gas release during charging of the retort.

3.4.4 The retort upper compartment will be operated slightly below atmospheric pressure as a further safeguard against accidental release of retort vapours.

3.4.5 Charcoal dust generated at the belt discharge chute into the furnace bins will be contained by a suppression system or dust collector and re-cycled back to the bin.

3.4.6 Transfer points on belt conveyors transporting charcoal will be fitted with dust suppression systems. The charcoal screen will be fitted with a dust collector, collected dust will be combined with charcoal fines from the screening operation.

3.4.7 The design of the waste wood handling system is under review; should an incinerator be utilised for burning wastes it will be of the "smokeless" refractory silo type.

3.4.8 The comprehensive fire suppression system for the charcoal process will consist of a water tank and pumping station which will feed a ring main and hydrant system around the charcoal retorts and docking mill area as well as the remainder of the plant. A sprinkler system will be installed for fire protection in the docking mill.

Personnel will be trained in fire-fighting procedures, equipment locations clearly marked and a fully operational fire tender will be maintained on site. Portable fire extinguishers and serviced hose reels will be located within the buildings as required.

3.4.9 Provision will be made for bleeding gas cooling water to a settling pond prior to further treatment. Washdown water will be fed through an oil separator prior to entering an evaporation pond or leach drain.

3.4.10 The retort controls will incorporate automatic shutdown system in the event of serious malfunction in shutdown mode top gases would continue to be passed through the high temperature incinerator until a stable cycle has been achieved.

3.5 SILICON PRODUCTION

3.5.1 The quartzite hopper, transfer point and conveyor system will be fitted with water mist sprays for dust suppression.

3.5.2 Each charcoal bin will be fitted with an emergency dumping gate, fitted to the lower section of bin, for use in case of spontaneous combustion of the charcoal.

3.5.3 The proponent will be exerting its best efforts to minimise and if practicable, eliminate the use of petcoke in its furnaces consistent with its commitment for safe and economical operations. The operation will be both environmentally and quality conscious.

3.5.4 The exhaust gas from each furnace and the entrained amorphous silica fume will be collected by the furnace and tapping area hoods and ducted through pre-collector/spark arrester units and a baghouse.

3.5.5 The fume will be discharged from the filter bags into sealed collection hoppers from where it will be pneumatically conveyed to storage silos. The fume will be discharged into sealed road vehicles or pelletised.

3.5.6 The proponent will introduce a programme for regularly sampling the fume and submitting the samples to X-ray diffraction analysis to detect any contamination by crystalline silica. (Public Health Implications Study p15).

3.5.7 The building housing the electric furnaces will be steel-clad. Appropriate ventilation and housekeeping measures will be adopted to ensure control and containment of dust within this building.

3.5.8 Waste water system is being reviewed. A disposal strategy for this waste water will be developed in consultation with the EPA after chemical analyses have been made.

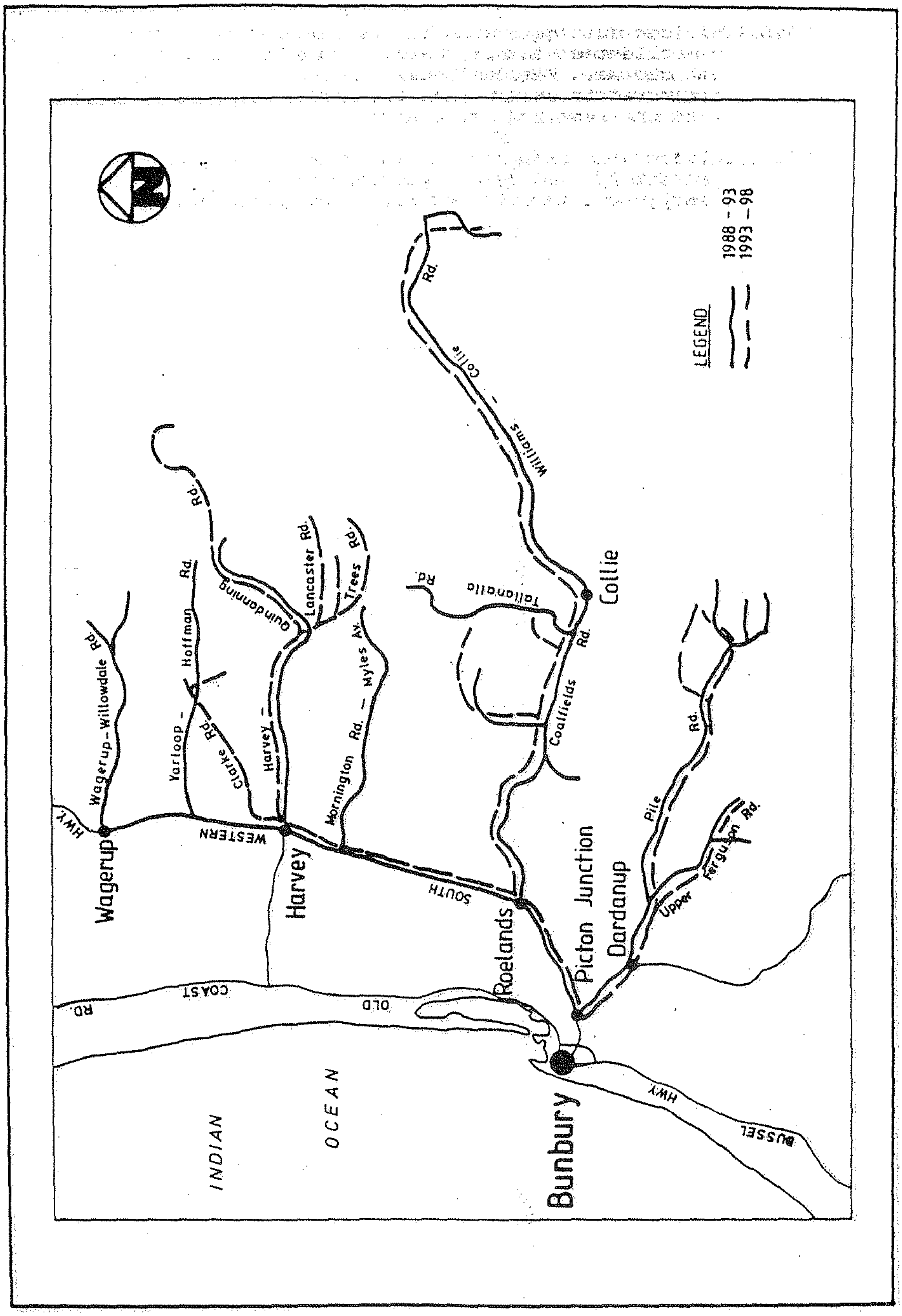
3.5.9 The oxygen storage facility of approximately 6000 litres will be isolated from the heat of the furnace, and fire hydrants will be installed in the general area.

3.5.10 The baghouse system will have reserve capacity to deal with abnormal dust burdens.

3.5.11 A monitoring programme will be established around the plant. That programme will be designed after consultation with the EPA.

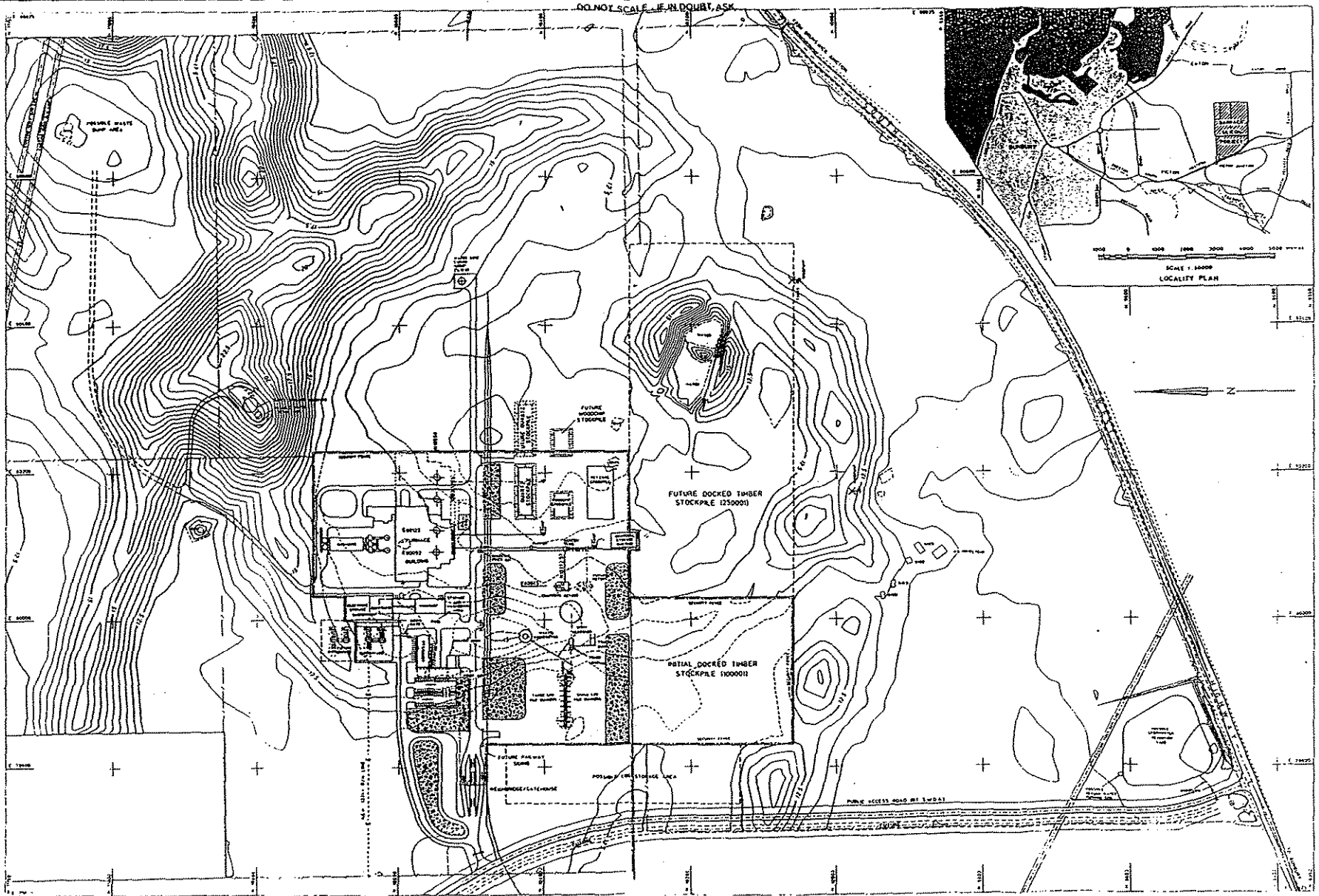
3.5.12 Silicon dust generated in the product treatment area will be collected via hoods and extraction fans and ducted to a baghouse. Residual dust levels will be regularly monitored to ensure that the control system is operating with the required efficiency.

3.5.13 Although no significant discharge of organics is predicted, samples of emissions will be collected during early operation of both furnaces and baghouses.



WOOD TRANSPORT CORRIDORS **FIGURE 6.2**

DO NOT SCALE - IF IN DOUBT, ASK



NOTES

LEGEND

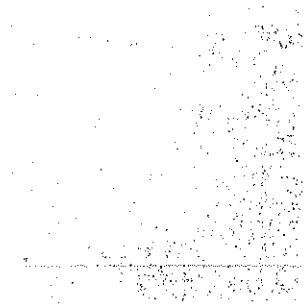
BHP Engineering Pty Ltd

BARRACK SILICON PTY. LTD.

BARRACK SILICON PROJECT

1. 2000 GENERAL ARRANGEMENT

SCALE 1:2000 | DWG No 100-G-002 / 0



APPENDIX H

EPA NOISE STUDIES

1. ASSESSMENT OF NOISE ENVIRONMENT AT EATON

2. BACKGROUND NOISE LEVEL DATA AT SOME SUBURBAN SITES

ASSESSMENT OF NOISE ENVIRONMENT AT EATON

INTRODUCTION

To assist in the environmental assessment of a proposal to establish a silicon smelter on a site to the south of the residential district of Eaton, near Bunbury, the current noise environment in Eaton was established.

Noise levels were measured continuously over the period 9 February to 23 February, 1988. This report records the results of that measurement and discusses the results obtained.

MEASUREMENT PROCEDURE

Instrumentation: The following Bruel and Kjaer instruments were used on the site: type 4165 microphone, type 2639 preamplifier, type 4426 noise level analyser and type 2312 alpha numeric printer. To assist with subsequent data processing the statistical data generated by the noise level analyser was also stored on a Canon X.07 computer.

Microphone Location: The measuring microphone was located on the garage roof at the residential property at 48, Lofthouse Street, Eaton. The height of the microphone above the garage roof was 1.2 metres. The microphone location, and the position of this residence within the Eaton area are shown in figure 1.

Field Performance Checks: The instrumentation was given field performance checks using a Bruel and Kjaer type 4230 acoustic calibrator prior to, part way through, and at the end of the measurement period. These checks indicated that no permanent drift in instrument sensitivity occurred during the measurement period.

RESULTS

The procedure used determines 8 selected average percentile values (L_N) and the equivalent steady noise level (L_{EQ}) for each hour of the total measurement period. The percentile levels determined were L_{01}, L_{05}, L_{10}, L_{20}, L_{50}, L_{90}, L_{95} and L_{99}.

This data is presented graphically in figures 2 to 5. Details of these figures are as follows:

Figure 2 presents a number of cumulative distribution curves:

- Curve A shows the average percentile values for the four hour period of each day which showed the lowest L_{EQ} values. This period always occurred between midnight and 0900 hours.
- Curve B shows the quietest of these four hour periods which occurred on 11 February, 1988.
- Curve C shows the average percentile values for the four hours on 11 February showing the highest L_{EQ} values.
- Curves D and E show the average percentile values for the remaining sixteen hours of 11 February. The hours showing the eight lower L_{EQ} values are represented by curve D whilst curve E represents the remaining eight hours.

2/....

- Curve F shows the four hour quiet period for 12 February. This particular period exhibited the highest noise levels seen in these quiet periods.

- Curves G, H and I present the remaining data for 12 February in the same manner as curves D, E and F.

Figure 3 presents selected L_{10} levels and shows the diurnal changes in the L_{10} level. The three curves represent two single days; 11 and 18 February, and the average of all days.

The two unusually high values observed at 1400 and 1500 hours on 11 February have been excluded from the average values as all other L_{10} levels determined were more than 10 dB lower.

Figure 4 presents selected L_{90} levels and shows the diurnal changes in the L_{90} level. The three curves represent two single days; 11 and 12 February and the average of all days.

Figure 5 shows the diurnal changes in the L_{EQ} for all weekdays and all weekend days over the period. The two unusually high values observed at 1400 and 1500 hours on 11 February, have not been excluded from these curves.

An L_{EQ} of 50 dB(A) was exceeded for 27 hours and an L_{EQ} of 55 dB(A) was exceeded for 5 hours in the total sample period of 335 hours. These times are 8.1% and 1.5% of the sample time respectively.

Appendix: Further information is appended to this report:

- The complete data base from which all graphical presentations have been derived.

- Noise level versus time curves for each parameter (L_N and L_{EQ}) over the total sample period.

COMMENTS ON RESULTS

The results obtained show the area to have a quiet, peaceful noise environment. The equivalent noise level (L_{EQ}) of 47 dB(A) observed for the full fourteen day measurement period is typical of an area where any intrusion of noise from transport and industrial sources is minimal and where any noise from such sources would be very noticeable.

The unusually high L_{10} levels observed for the 1300 to 1500 hours period on 11 February suggest the operation of a lawn mower, chain saw or similar machine in the vicinity of the microphone. This activity had no significant influence on the L_{90} levels for this period.

Figures 2, 3 and 4 are based in part on data from single days. The reasons for choosing these particular days were as follows:

3/.....

11 February: This day showed the lowest L_{10} and L_{90} levels during the quietest four hour period of any day, and also (by chance) showed particularly high daytime noise levels.

12 February: This day showed the highest L_{90} levels during the quietest four hour period of any day.

18 February: This day showed the highest L_{10} levels during the quietest four hour period of any day.

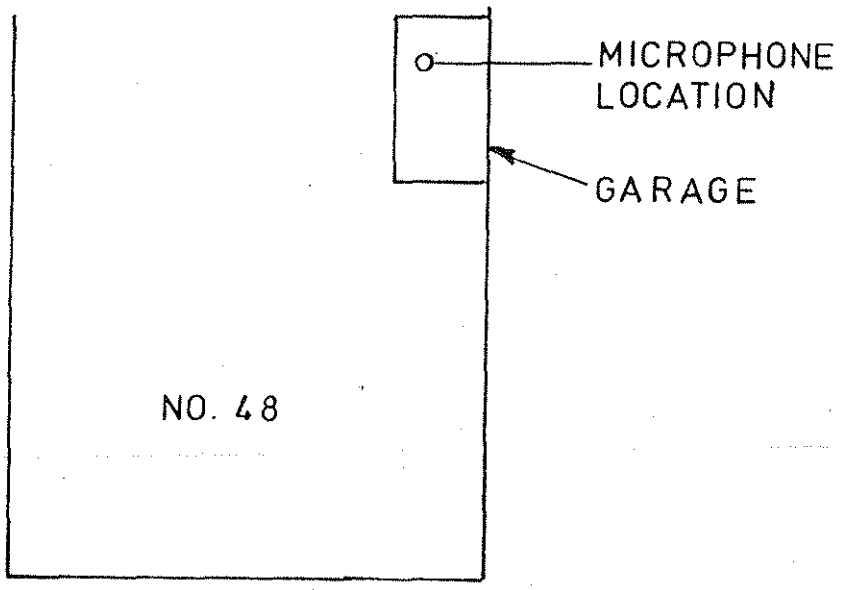
During the quiet overnight periods the dominant factor influencing the L_{90} levels (and also most other parameters) will be wind velocity.

To maintain this noise environment, noise emissions from any industrial source ideally should be inaudible.

Industrial activities showing noise levels in excess of 45 dB(A) L_{EQ} during the period 0700 to 2200 hours and in excess of 30 dB(A) L_{EQ} during the period 2200 to 0700 hours, would be clearly audible in the Eaton residential area given the noise environment measured.

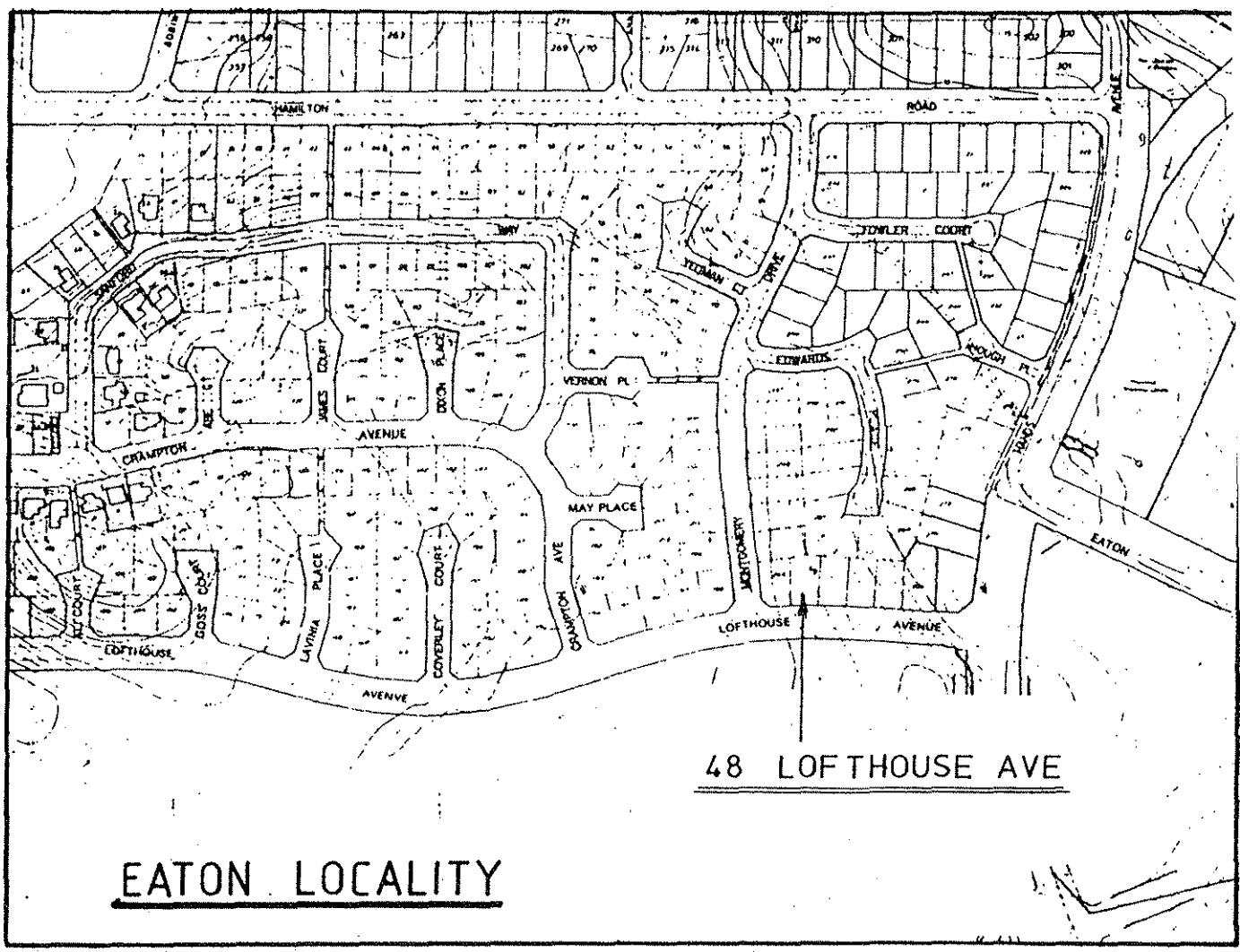
NOISE MEASUREMENT SITE EATON

FIGURE



LOFTHOUSE AVE

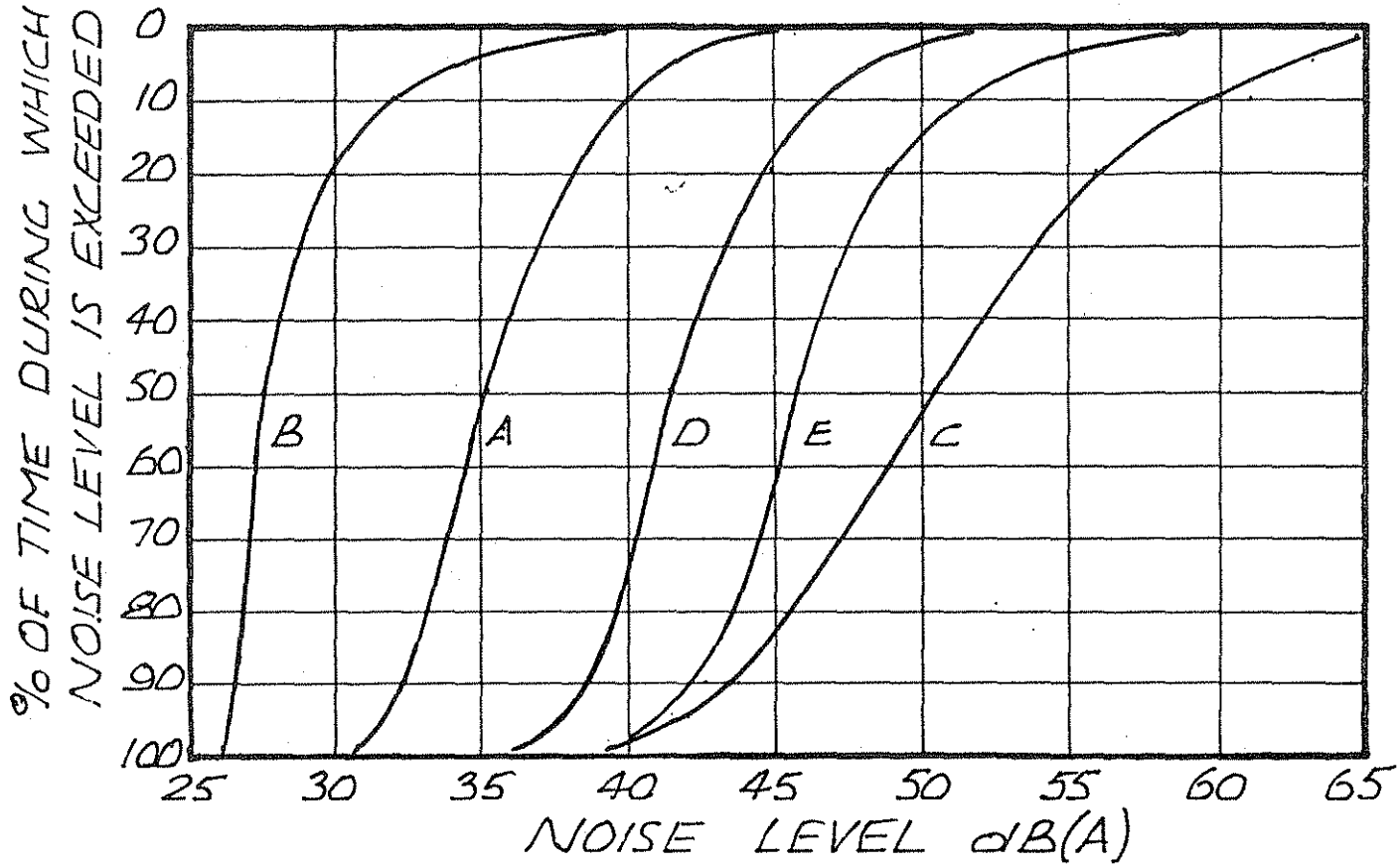
TEMPORARY END TO ROAD



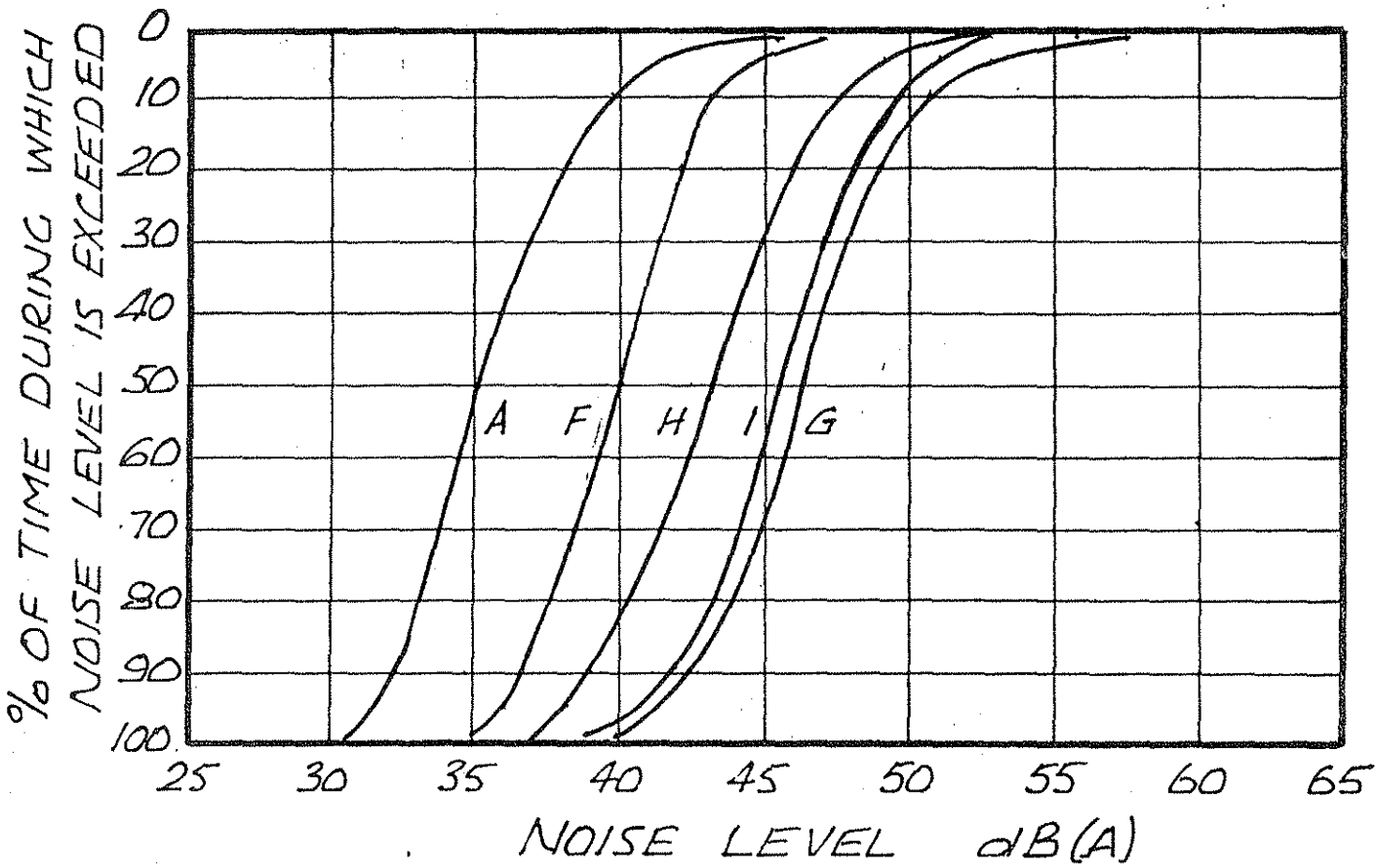
EATON LOCALITY

CUMULATIVE NOISE LEVEL DISTRIBUTION

FIGURE 2

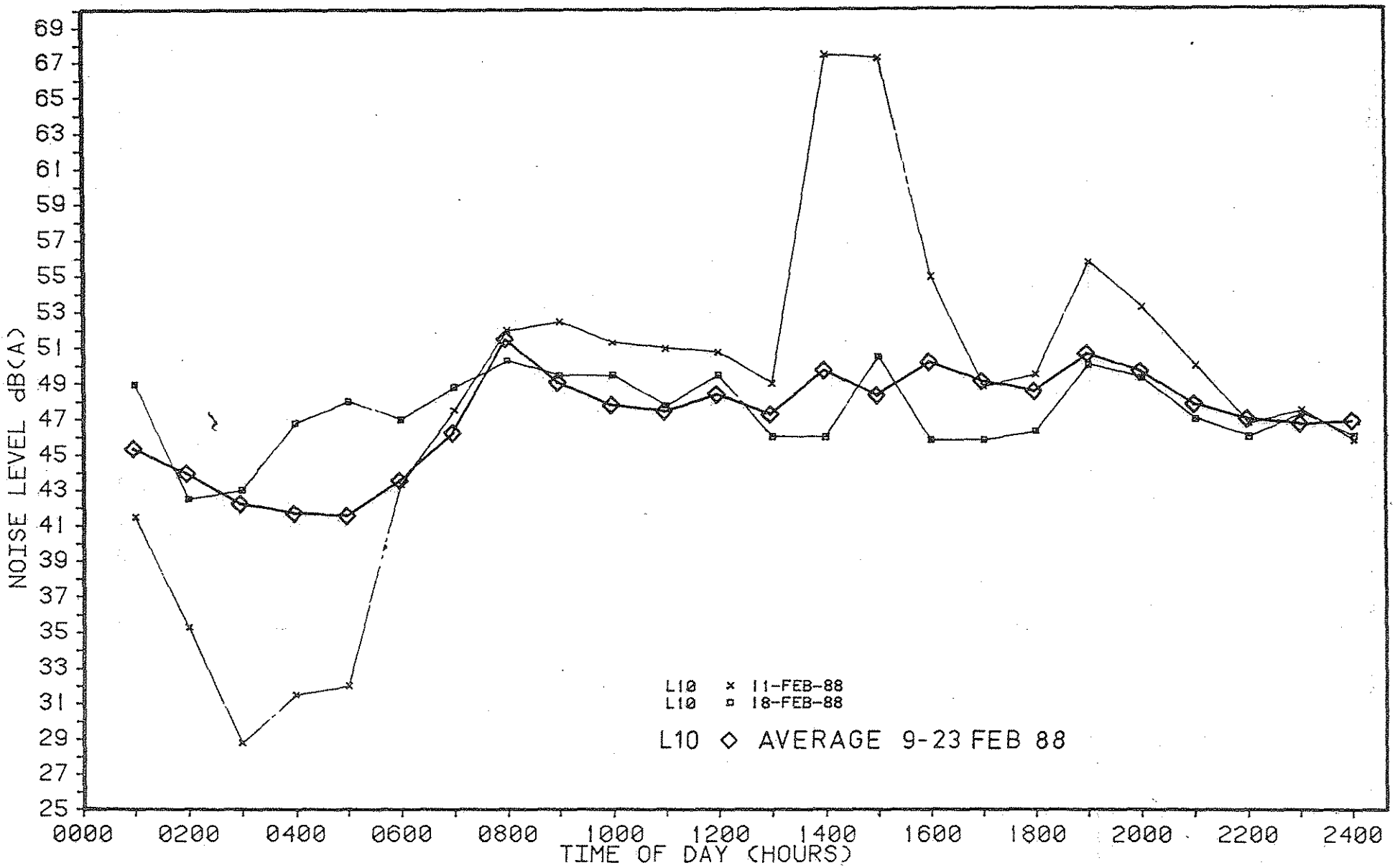


AVERAGE (A) & CURVES FOR 11·2·1988



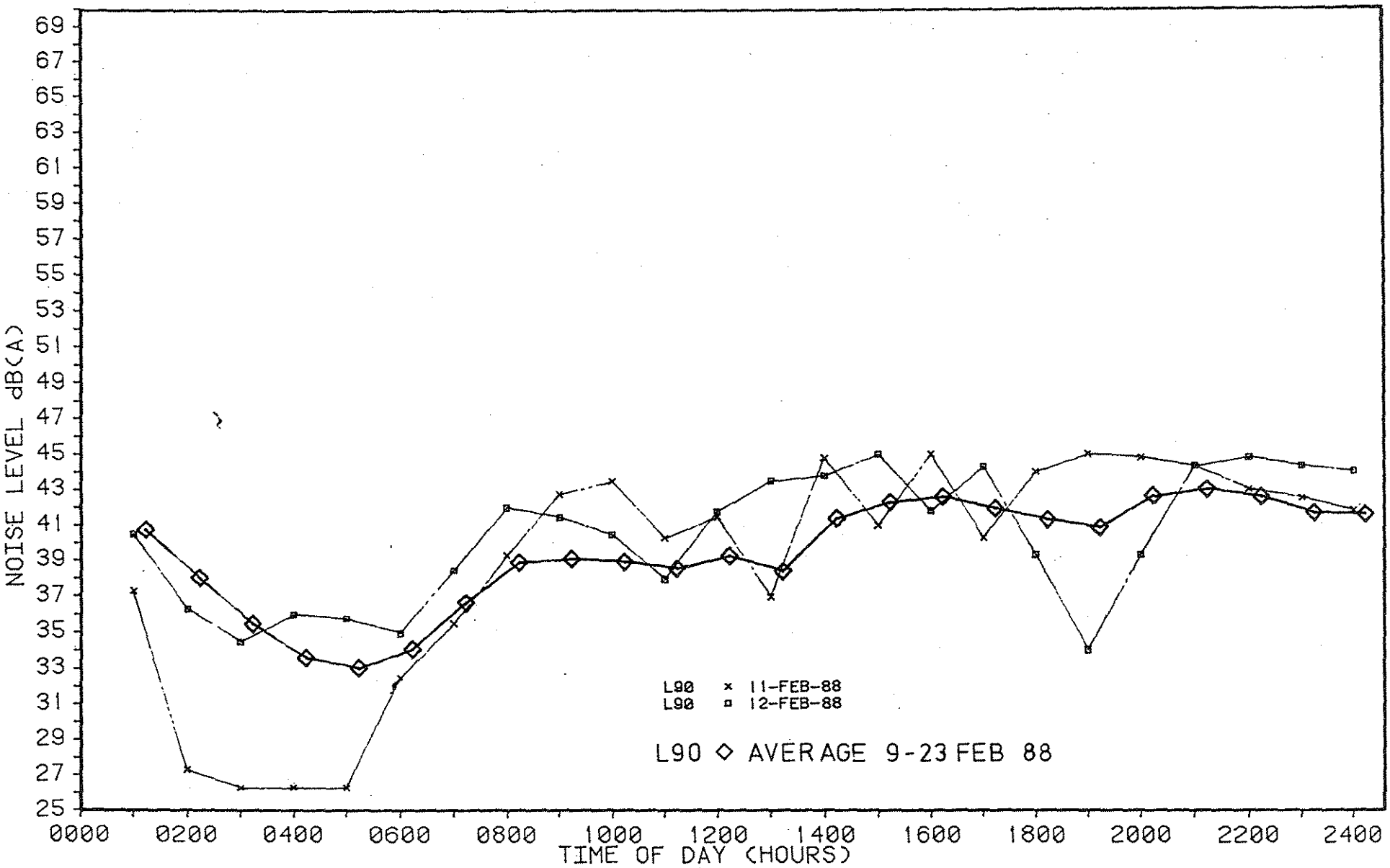
AVERAGE (A) & CURVES FOR 12·2·1988

R2.88



HOURLY NOISE LEVELS AT 48 LOFTHOUSE STREET, EATON

FIGURE 3



HOURLY NOISE LEVELS AT 48 LOFTHOUSE STREET, EATON

FIGURE 4

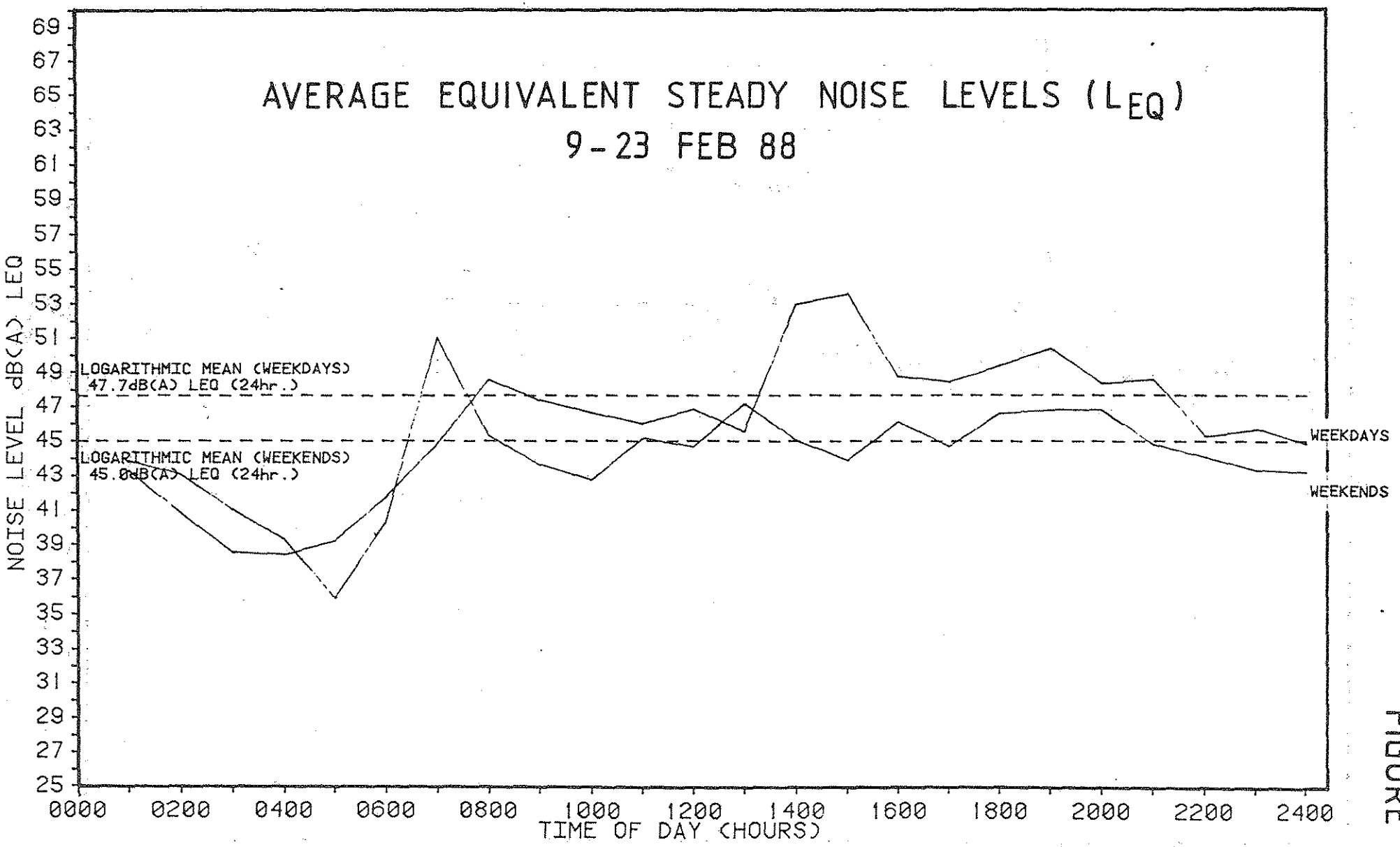


FIGURE 5

HOURLY NOISE LEVELS AT 48 LOFTHOUSE STREET, EATON FOR 09-FEB-88 TO 23-FEB-88

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
09/02/88									
100	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
200	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
300	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
400	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
500	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
600	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
700	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
800	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
900	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1000	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1100	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1200	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1300	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1400	55.3	65.8	58.3	54.3	51.3	49.0	44.0	40.5	37.8
1500	49.5	55.5	52.0	50.8	49.8	48.3	46.0	45.3	44.0
1600	48.8	55.5	51.8	50.8	49.8	48.6	45.3	44.3	41.8
1700	50.7	58.3	52.8	50.8	49.5	47.5	43.8	42.3	39.8
1800	49.2	59.8	51.5	49.5	48.0	46.0	41.8	40.5	38.8
1900	52.9	64.5	56.8	53.0	49.8	46.3	42.8	42.0	40.5
2000	49.4	56.5	52.3	51.3	50.5	48.5	46.0	45.3	44.5
2100	48.2	52.8	51.3	50.3	49.3	47.8	45.3	44.8	44.3
2200	48.1	51.8	50.5	50.3	49.5	48.0	45.8	44.8	43.0
2300	45.8	50.3	49.0	48.5	47.5	45.5	41.8	41.3	40.5
2400	42.8	47.0	45.3	44.8	44.0	42.5	40.5	39.8	38.0

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
10/02/88									
100	41.7	47.0	44.8	44.0	43.0	41.3	38.0	36.0	34.0
200	36.1	43.0	40.8	39.5	38.3	34.3	30.5	29.8	29.0
300	34.9	40.8	38.0	37.0	36.3	35.3	30.0	29.0	28.0
400	33.1	42.8	38.0	35.0	33.0	30.8	27.5	27.0	26.3
500	33.4	43.3	38.8	36.8	34.3	30.3	27.3	27.0	26.5
600	40.0	51.0	44.5	42.3	39.8	34.3	29.8	29.0	27.8
700	44.1	54.3	49.0	46.8	44.5	39.8	33.3	32.3	31.3
800	49.1	59.3	54.8	52.0	49.0	45.0	40.5	38.8	36.0
900	49.7	60.8	55.5	52.8	49.3	45.5	42.3	41.8	40.5
1000	48.2	58.8	52.8	50.3	47.3	43.3	39.5	38.3	36.0
1100	45.5	54.5	50.0	48.0	45.8	42.5	38.3	36.8	34.8
1200	46.9	56.5	52.0	49.3	46.8	44.0	41.3	40.8	39.5
1300	48.7	60.3	53.3	50.8	48.0	44.0	36.8	35.3	32.8
1400	47.9	57.3	51.5	49.8	48.0	46.0	43.8	43.3	42.5
1500	49.9	59.5	54.0	51.5	49.5	46.8	44.5	43.5	42.0
1600	51.2	62.0	55.0	52.3	49.8	47.0	44.8	44.0	43.0
1700	50.1	60.0	53.8	51.8	49.8	47.0	44.8	44.0	43.3
1800	45.3	51.8	49.0	47.5	46.3	44.3	42.3	41.8	40.8
1900	49.9	61.0	56.0	52.5	49.3	45.0	41.8	41.0	39.8
2000	48.1	56.5	51.5	49.5	48.0	46.5	43.8	42.8	41.3
2100	46.0	49.5	48.5	48.0	47.0	45.8	44.3	43.8	42.8
2200	46.4	51.3	50.0	48.8	47.5	46.3	43.5	43.0	42.3
2300	45.1	50.0	48.8	47.8	46.3	44.3	42.3	41.8	41.0
2400	44.6	50.5	49.3	48.3	46.8	43.0	41.0	40.5	40.0

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
11/02/88									
100	39.9	45.8	42.5	41.5	40.5	39.3	37.3	36.5	35.8
200	32.4	40.5	37.5	35.3	33.8	29.8	27.3	27.0	26.5
300	27.5	32.8	30.0	28.8	27.8	26.3	26.3	26.3	26.3
400	30.8	42.8	35.5	31.5	28.5	26.3	26.3	26.3	26.3
500	29.9	40.0	34.8	32.0	29.8	27.3	26.3	26.3	26.3
600	42.1	51.5	46.0	43.3	40.5	36.0	32.5	31.8	30.8
700	44.4	54.3	49.8	47.5	45.3	40.5	35.5	34.8	33.8
800	49.5	60.8	55.0	52.0	48.8	45.5	39.3	37.8	35.3
900	49.6	60.3	55.5	52.5	49.3	45.8	42.8	42.0	40.8
1000	48.7	58.3	53.5	51.3	48.8	46.0	43.5	42.8	41.8
1100	49.0	61.3	54.0	51.0	48.0	44.5	40.3	39.0	36.8
1200	48.6	58.8	53.0	50.8	48.5	45.0	41.5	40.5	38.8
1300	46.9	56.0	51.5	49.0	47.3	43.8	37.0	35.3	32.0
1400	60.6	70.8	69.0	67.5	53.8	47.3	44.8	44.0	42.3
1500	62.5	70.8	68.8	67.3	65.3	57.3	41.0	39.0	36.5
1600	51.3	61.5	57.5	55.0	50.5	47.5	45.0	43.8	38.3
1700	47.1	54.8	50.3	48.8	47.8	46.0	40.3	37.3	35.3
1800	47.7	55.3	50.8	49.5	48.3	46.5	44.0	43.3	41.5
1900	52.9	63.0	58.3	55.8	53.0	48.8	45.0	43.0	40.0
2000	52.3	61.0	55.8	53.3	51.0	48.0	44.8	42.5	39.0
2100	47.4	53.8	50.8	50.0	48.3	46.5	44.3	44.0	43.3
2200	45.2	49.5	47.3	46.8	46.3	45.0	43.0	42.8	42.0
2300	45.3	50.0	48.3	47.5	46.5	45.0	42.5	41.8	41.3
2400	44.1	49.5	46.8	45.8	45.0	43.8	41.8	41.3	40.8

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
12/02/88									
100	43.0	46.8	45.0	44.5	44.0	43.0	40.5	39.8	39.0
200	40.2	44.0	42.5	42.0	41.5	40.0	36.3	35.3	33.8
300	39.1	47.5	43.0	41.5	40.0	37.5	34.5	34.0	32.8
400	42.0	50.0	47.0	45.3	43.5	39.8	36.0	35.3	34.3
500	43.9	51.5	48.5	47.3	45.8	42.0	35.8	35.0	34.0
600	43.5	52.0	46.8	44.5	42.3	38.3	35.0	34.5	34.0
700	46.4	55.0	49.8	47.8	46.0	42.5	38.5	37.5	36.0
800	49.0	59.3	54.5	51.5	49.3	45.8	42.0	41.0	40.0
900	49.0	59.3	54.3	52.0	49.0	45.0	41.5	40.5	39.5
1000	48.1	59.3	52.5	50.0	47.5	44.3	40.5	39.5	38.3
1100	47.2	58.3	51.5	49.0	46.5	42.5	38.0	37.0	36.0
1200	48.1	58.0	51.5	50.3	49.0	46.3	41.8	40.8	39.0
1300	48.7	55.3	51.3	50.3	49.5	48.0	43.5	41.3	38.8
1400	48.4	56.8	51.3	50.3	49.3	47.0	43.8	42.5	39.0
1500	47.6	55.0	50.8	49.3	48.0	46.8	45.0	44.8	43.8
1600	46.5	54.8	50.0	48.8	47.5	44.8	41.8	40.8	38.8
1700	47.6	53.8	51.0	50.0	48.8	47.0	44.3	42.8	39.8
1800	47.7	53.8	50.3	49.3	48.3	46.8	39.3	37.0	34.8
1900	46.8	57.0	49.8	47.5	45.0	40.5	34.0	32.0	30.3
2000	45.6	50.8	49.0	48.3	47.5	45.5	39.3	38.8	37.3
2100	55.8	55.5	50.8	49.5	48.5	47.3	44.3	43.0	41.8
2200	46.8	50.5	49.0	48.5	47.8	46.5	44.8	44.3	43.5
2300	46.7	51.0	50.3	49.3	48.0	46.3	44.3	43.8	43.0
2400	47.7	51.8	51.0	50.5	50.0	46.8	44.0	43.5	42.8

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
13/02/88									
100	43.3	48.3	46.0	45.0	44.0	43.0	41.8	41.5	41.0
200	44.1	49.5	47.5	46.5	45.5	43.8	41.3	40.5	38.0
300	41.8	48.0	45.0	44.0	43.0	41.0	39.0	38.8	37.8
400	42.7	50.0	46.5	45.3	44.0	41.8	38.8	38.3	36.5
500	37.4	44.5	41.8	40.5	38.8	36.0	33.5	33.0	32.3
600	39.6	47.0	43.3	41.3	39.8	37.5	35.5	35.0	34.5
700	41.9	50.3	46.3	44.3	42.3	39.3	36.5	35.8	34.8
800	50.5	56.5	55.3	54.5	53.5	48.3	39.8	38.5	37.0
900	46.7	59.5	52.0	48.5	45.5	41.8	37.5	37.0	36.0
1000	45.3	55.0	50.3	47.8	45.3	42.0	38.0	37.0	35.3
1100	45.9	57.0	52.3	48.5	45.3	42.3	38.0	37.3	35.8
1200	43.7	53.0	47.8	45.8	44.0	40.8	36.5	35.5	32.5
1300	44.0	50.8	48.0	46.8	45.8	43.5	37.8	36.3	33.5
1400	43.8	50.3	47.5	46.5	45.5	43.3	37.3	36.0	34.3
1500	43.7	49.8	47.3	46.3	45.3	43.3	39.3	38.0	36.5
1600	44.3	51.8	47.5	46.0	44.8	42.8	38.5	37.3	35.5
1700	44.6	56.8	48.8	45.8	43.8	41.0	35.8	34.0	31.8
1800	46.3	60.0	50.0	46.8	44.5	41.0	36.8	35.5	33.0
1900	47.1	57.5	52.0	49.5	46.8	43.0	39.0	37.5	35.5
2000	49.4	57.8	53.8	52.0	50.3	48.0	43.5	41.5	39.3
2100	47.2	51.0	49.5	49.0	48.5	47.0	45.0	44.5	43.5
2200	46.1	49.8	48.8	48.3	46.8	45.8	44.5	44.3	43.3
2300	46.1	49.8	48.0	47.5	47.0	46.0	44.3	43.8	43.0
2400	46.9	51.5	49.0	48.3	47.8	46.8	45.3	44.8	43.8

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
14/02/88									
100	46.0	49.8	48.0	47.5	47.0	46.0	44.5	43.8	41.3
200	44.5	48.8	47.8	47.0	46.3	44.8	40.0	39.5	38.8
300	41.9	47.0	46.3	45.8	44.3	40.5	37.0	36.8	35.8
400	35.5	43.3	38.5	37.8	36.5	34.3	32.0	31.3	30.0
500	35.2	41.0	38.0	37.0	36.3	34.5	32.5	31.8	30.5
600	41.2	49.5	44.5	42.3	39.8	37.0	34.3	33.8	32.8
700	40.5	48.8	45.3	43.0	41.0	38.3	35.8	35.0	34.3
800	38.1	46.8	42.8	41.0	38.3	35.0	31.8	31.0	30.3
900	37.8	46.8	42.5	40.5	38.5	34.5	31.0	30.3	29.8
1000	41.3	50.0	45.0	43.3	41.8	38.3	33.5	32.8	31.3
1100	44.8	54.0	46.3	45.0	44.0	42.3	35.0	34.0	32.5
1200	45.6	58.0	47.5	44.3	42.5	40.3	35.5	34.0	31.5
1300	39.6	45.5	43.0	42.3	41.3	39.3	32.5	31.5	30.0
1400	41.7	49.0	45.8	44.5	43.0	40.5	36.8	36.0	35.0
1500	45.8	54.3	49.8	47.8	46.3	44.3	42.0	41.5	40.3
1600	47.8	55.3	51.3	50.0	48.5	46.3	43.8	43.0	41.8
1700	47.9	55.0	51.0	50.0	48.8	46.8	44.8	44.0	43.0
1800	49.1	57.5	52.8	50.8	48.8	46.3	43.3	42.3	40.5
1900	44.7	54.5	48.3	46.3	44.5	42.5	39.0	38.3	37.3
2000	45.3	53.0	48.0	47.0	46.3	44.8	40.5	39.8	37.8
2100	44.5	49.0	46.5	45.8	45.3	44.0	43.0	42.8	42.3
2200	43.1	47.5	45.3	44.5	43.8	42.8	42.0	41.5	41.0
2300	43.5	47.5	45.5	44.8	44.3	43.3	42.3	41.8	41.0
2400	42.6	46.3	44.8	44.3	43.8	42.5	41.0	40.5	39.8

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
15/02/88									
100	41.5	44.8	43.8	42.8	42.3	41.5	40.3	40.0	39.0
200	40.6	43.0	42.3	42.0	41.8	40.8	39.0	38.5	38.0
300	39.2	42.8	41.0	40.8	40.3	39.5	37.0	36.3	35.3
400	35.6	44.5	39.0	37.8	36.3	34.0	33.3	31.8	31.0
500	35.1	44.0	39.5	37.3	35.5	33.3	31.0	30.5	29.8
600	38.0	46.8	43.0	40.3	37.3	34.3	31.8	31.3	30.8
700	47.7	54.3	49.8	47.5	45.3	41.5	37.8	37.0	35.5
800	45.9	55.5	50.5	48.0	45.5	41.3	37.3	36.5	35.8
900	45.2	55.8	50.8	47.5	43.8	40.5	37.0	36.0	35.0
1000	45.8	55.8	49.8	47.3	45.8	43.3	39.5	38.5	37.0
1100	45.7	56.5	49.0	46.3	44.3	42.8	40.3	39.3	37.0
1200	43.7	52.5	46.8	45.0	43.8	41.3	36.0	35.3	34.3
1300	44.8	54.3	49.3	47.3	45.5	43.0	38.8	38.0	36.8
1400	45.2	52.3	48.8	47.5	46.3	44.5	41.8	40.8	39.3
1500	47.4	53.8	51.3	50.0	48.8	46.5	43.5	42.8	42.0
1600	51.6	62.3	59.0	54.0	50.3	47.5	45.0	44.3	43.0
1700	48.5	57.8	52.3	50.0	48.3	46.5	44.5	43.8	42.8
1800	46.7	52.5	49.8	48.5	47.5	46.0	44.5	44.0	43.3
1900	46.6	54.0	50.0	48.5	47.0	45.3	43.0	42.5	41.3
2000	49.1	58.0	52.0	50.3	49.0	47.8	43.8	43.0	42.0
2100	45.5	49.3	48.5	48.3	47.8	45.3	41.3	41.0	40.5
2200	44.3	47.8	46.5	46.3	45.8	44.3	41.5	41.0	40.3
2300	43.4	49.0	46.0	45.0	44.3	43.0	41.3	41.0	40.5
2400	45.0	51.0	50.3	49.3	46.0	43.3	41.0	40.8	40.0

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
16/02/88									
100	48.6	51.0	50.5	50.3	50.0	49.3	45.3	43.8	41.0
200	46.5	50.5	50.0	49.5	48.8	45.5	42.3	40.8	39.3
300	41.3	48.3	45.3	44.0	43.0	40.8	37.0	36.5	35.0
400	34.7	42.8	38.3	37.5	35.8	33.3	31.0	30.8	30.0
500	36.1	45.5	40.8	38.0	36.0	33.3	30.5	30.0	29.3
600	39.6	49.3	45.8	43.5	40.5	35.5	32.0	31.3	30.3
700	41.8	50.8	47.3	45.3	43.0	38.8	35.0	34.5	33.5
800	46.4	56.5	51.3	48.8	46.0	42.8	38.3	37.3	36.0
900	45.7	57.3	51.5	48.3	45.3	41.3	36.0	34.0	32.3
1000	45.3	56.3	50.5	47.5	44.5	41.5	36.3	34.8	33.5
1100	44.2	53.0	46.5	44.5	43.3	41.8	39.3	38.3	36.5
1200	47.0	55.8	53.3	52.0	47.8	42.0	37.3	36.3	34.3
1300	42.0	49.0	46.0	44.5	42.8	40.0	36.8	36.3	35.5
1400	51.3	62.3	60.0	55.8	47.3	44.3	41.8	41.3	40.3
1500	44.9	53.0	49.0	47.0	45.5	43.3	41.3	40.8	40.0
1600	46.0	55.5	50.3	47.8	46.0	43.8	41.8	41.3	40.3
1700	48.0	62.0	49.8	47.0	45.3	43.3	41.3	40.8	40.0
1800	50.7	58.8	49.3	46.5	45.0	43.0	41.0	40.5	39.5
1900	45.1	53.5	48.3	46.3	44.3	42.0	38.5	37.8	36.5
2000	47.3	54.3	49.8	49.3	48.8	46.5	41.5	40.5	38.5
2100	46.2	50.3	49.3	48.8	48.0	46.0	42.8	42.3	41.3
2200	43.3	48.3	45.8	44.8	44.0	42.8	41.3	41.0	39.5
2300	43.5	48.3	45.8	45.0	44.3	43.3	42.0	41.8	41.0
2400	42.2	45.8	44.5	43.8	43.3	42.0	40.5	40.0	39.5

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
17/02/88									
100	42.2	44.5	44.0	43.8	43.3	42.3	40.8	40.3	39.5
200	42.9	46.0	44.5	44.3	43.8	43.0	41.5	41.0	40.3
300	39.3	45.0	42.5	41.3	40.3	38.8	37.0	36.5	35.5
400	34.5	40.8	38.5	37.5	36.3	33.3	29.8	28.8	27.6
500	34.9	44.3	38.5	36.3	33.0	29.5	26.3	26.3	26.3
600	40.4	50.3	44.0	41.3	38.0	34.5	29.5	28.3	26.8
700	42.4	52.5	47.3	45.0	42.8	38.3	34.3	33.5	32.5
800	46.2	56.5	51.3	49.3	46.5	42.5	37.0	35.5	33.8
900	46.7	57.5	51.8	49.0	46.3	42.5	38.3	37.3	35.3
1000	45.1	55.8	49.5	46.8	44.5	41.8	37.8	36.5	35.0
1100	43.5	53.3	47.8	45.5	43.8	41.3	37.3	35.8	34.3
1200	46.2	57.5	51.3	47.8	44.5	41.8	37.3	35.5	33.8
1300	43.9	50.8	47.5	46.3	45.0	43.0	37.8	36.5	34.3
1400	50.8	62.3	53.5	50.3	47.5	44.3	40.8	40.0	36.3
1500	44.5	52.8	48.3	46.0	44.5	42.5	40.0	39.5	37.5
1600	44.6	53.5	48.8	46.3	44.8	43.0	41.3	40.8	40.0
1700	45.6	54.3	49.3	47.5	45.8	43.8	41.8	41.3	40.5
1800	53.9	64.3	51.5	48.3	45.5	42.5	39.0	38.0	36.5
1900	49.5	62.5	55.8	50.0	45.0	41.3	35.8	34.3	32.3
2000	44.6	53.3	48.8	47.0	45.3	42.3	36.8	35.0	33.0
2100	44.7	50.5	47.8	46.8	45.8	44.3	42.3	41.8	41.3
2200	45.9	51.5	49.3	48.3	47.0	45.3	43.5	43.0	42.5
2300	46.0	52.0	49.8	48.5	47.0	45.3	43.3	42.8	41.6
2400	46.2	52.5	50.0	48.5	47.3	45.8	43.0	42.0	41.0

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
18/02/88									
100	45.7	52.5	50.3	49.0	47.5	43.5	40.8	40.3	39.0
200	40.0	44.8	43.3	42.5	41.5	39.5	36.3	35.5	34.5
300	39.9	47.5	44.3	43.0	41.5	37.8	34.0	32.8	31.8
400	43.2	51.0	48.3	46.8	44.8	41.3	36.5	35.5	34.5
500	45.2	53.8	49.5	48.0	46.5	43.3	39.8	38.8	36.8
600	44.3	52.3	49.0	47.0	45.3	42.5	39.5	38.8	37.8
700	46.1	54.0	50.5	48.8	47.0	44.0	40.3	39.8	38.8
800	47.9	57.3	52.5	50.3	48.3	45.0	41.8	41.0	39.8
900	47.3	57.8	51.8	49.5	47.5	44.5	40.8	40.0	38.8
1000	47.7	57.3	52.3	49.5	47.0	44.3	40.8	39.8	38.0
1100	46.0	56.5	50.5	47.8	46.0	43.3	39.8	39.0	37.5
1200	46.7	56.8	51.8	49.5	47.0	44.0	40.8	40.3	39.0
1300	43.2	52.5	48.3	46.0	43.8	40.5	37.5	36.5	34.8
1400	44.7	55.3	48.3	46.0	44.0	41.3	37.5	36.5	34.8
1500	49.4	62.8	54.8	50.5	46.8	43.8	40.3	39.3	37.8
1600	45.4	53.3	47.8	45.8	44.0	41.8	39.0	37.5	33.8
1700	43.4	52.0	48.0	45.8	44.3	42.0	36.3	34.5	33.3
1800	43.3	52.5	48.3	46.3	44.0	41.3	36.3	35.0	33.5
1900	50.2	62.5	54.5	50.0	47.5	44.3	40.8	40.0	39.0
2000	48.2	57.5	51.5	49.3	47.8	45.5	43.5	42.8	41.8
2100	45.3	50.5	48.0	47.0	46.0	44.5	43.3	43.0	42.5
2200	43.9	50.0	47.5	46.0	45.0	43.0	40.0	39.0	38.0
2300	44.9	49.8	48.3	47.3	46.3	44.5	39.8	38.5	37.3
2400	43.7	48.5	47.0	46.0	45.0	43.3	41.3	40.5	39.3

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
19/02/88									
100	42.7	45.8	44.3	43.8	43.5	42.8	41.3	40.8	39.5
200	41.8	46.3	44.0	43.8	43.3	42.0	38.8	37.8	36.3
300	41.2	46.5	44.3	43.5	42.8	40.5	38.3	37.8	36.8
400	40.6	47.5	44.5	43.5	42.3	39.5	35.8	35.3	33.8
500	38.0	45.8	42.8	41.5	39.0	36.0	34.3	33.8	33.3
600	41.4	49.5	46.0	44.0	42.3	39.5	36.3	35.8	34.8
700	42.7	52.0	47.8	45.8	43.8	39.5	35.8	35.0	34.0
800	43.6	52.0	48.5	46.3	44.3	40.8	37.8	37.3	35.8
900	43.5	51.8	47.5	45.5	44.0	41.8	39.5	39.0	37.0
1000	44.7	54.3	48.8	46.5	44.5	42.3	40.5	40.3	39.5
1100	43.5	49.3	46.3	45.3	44.5	43.0	41.0	40.5	39.8
1200	43.6	49.3	46.5	45.5	44.5	43.0	41.3	40.8	40.0
1300	43.3	49.5	46.5	45.3	44.0	43.5	41.0	40.8	40.0
1400	42.7	47.8	45.0	44.3	43.5	42.5	41.0	40.5	40.0
1500	43.1	48.8	45.8	44.8	44.0	42.8	40.5	40.0	39.0
1600	43.3	52.5	46.5	44.5	43.3	41.3	39.3	38.5	36.8
1700	43.3	51.0	46.8	45.0	43.3	41.3	39.3	38.8	37.3
1800	42.3	50.5	45.0	43.5	42.5	40.8	38.3	37.5	35.8
1900	42.6	53.3	46.3	43.8	42.3	40.0	37.0	36.5	35.5
2000	44.7	51.3	48.3	47.0	45.3	43.5	40.3	39.5	38.3
2100	44.1	48.3	46.0	45.5	44.8	43.8	41.8	41.0	39.0
2200	43.6	48.0	46.3	45.5	45.3	43.5	40.8	40.0	39.0
2300	50.0	54.0	48.8	47.5	45.5	43.5	40.5	39.3	38.0
2400	47.0	50.0	49.3	49.0	48.8	47.8	42.8	41.8	39.5

48 LOFTHOUSE STREET, EATON

	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
20/02/88									
100	43.9	48.0	46.5	46.3	45.5	43.8	40.5	39.8	37.8
200	43.3	47.8	46.3	45.5	45.0	43.5	37.8	37.3	36.0
300	41.9	46.8	46.3	45.8	44.5	40.5	36.3	35.8	34.8
400	39.9	45.5	44.3	43.5	42.0	38.5	34.3	33.8	32.5
500	36.7	44.3	41.8	40.5	38.0	34.8	32.8	32.0	30.3
600	39.7	50.0	44.3	41.8	38.8	34.0	30.5	29.8	29.0
700	56.7	52.5	47.3	45.8	43.5	39.0	34.5	33.8	32.8
800	40.2	48.8	45.3	43.5	41.3	37.8	33.8	33.0	32.0
900	42.6	52.3	45.5	43.5	41.5	37.0	33.0	32.5	31.3
1000	40.8	49.5	45.5	43.8	42.0	37.8	34.0	33.3	32.3
1100	42.9	52.3	48.3	45.5	43.5	40.3	36.3	35.3	34.3
1200	43.3	54.3	48.0	45.0	42.0	39.0	35.0	34.3	33.5
1300	40.4	47.3	44.0	42.5	41.3	39.5	36.8	36.0	35.0
1400	42.6	50.5	46.3	44.8	43.3	41.0	38.8	38.3	37.3
1500	43.1	49.8	46.5	45.0	43.8	42.3	40.0	39.3	38.0
1600	48.0	58.3	50.3	47.0	44.5	41.8	39.5	39.3	38.5
1700	41.6	48.3	45.3	44.0	43.0	40.8	38.3	37.5	36.5
1800	42.3	48.5	45.8	44.5	43.5	41.0	38.0	37.3	36.0
1900	39.4	45.3	42.8	41.8	40.5	38.8	36.5	36.0	35.3
2000	39.5	45.8	43.0	41.8	40.8	38.8	36.3	35.3	33.8
2100	40.6	46.8	45.3	44.3	42.5	38.8	35.8	35.3	33.5
2200	41.3	47.0	45.8	44.8	43.0	39.8	36.8	36.3	35.5
2300	40.8	46.3	44.5	43.3	42.5	40.0	37.3	36.3	35.3
2400	40.1	46.3	43.0	42.0	41.0	39.5	38.0	37.5	36.8

48 LOFTHOUSE STREET, EATON

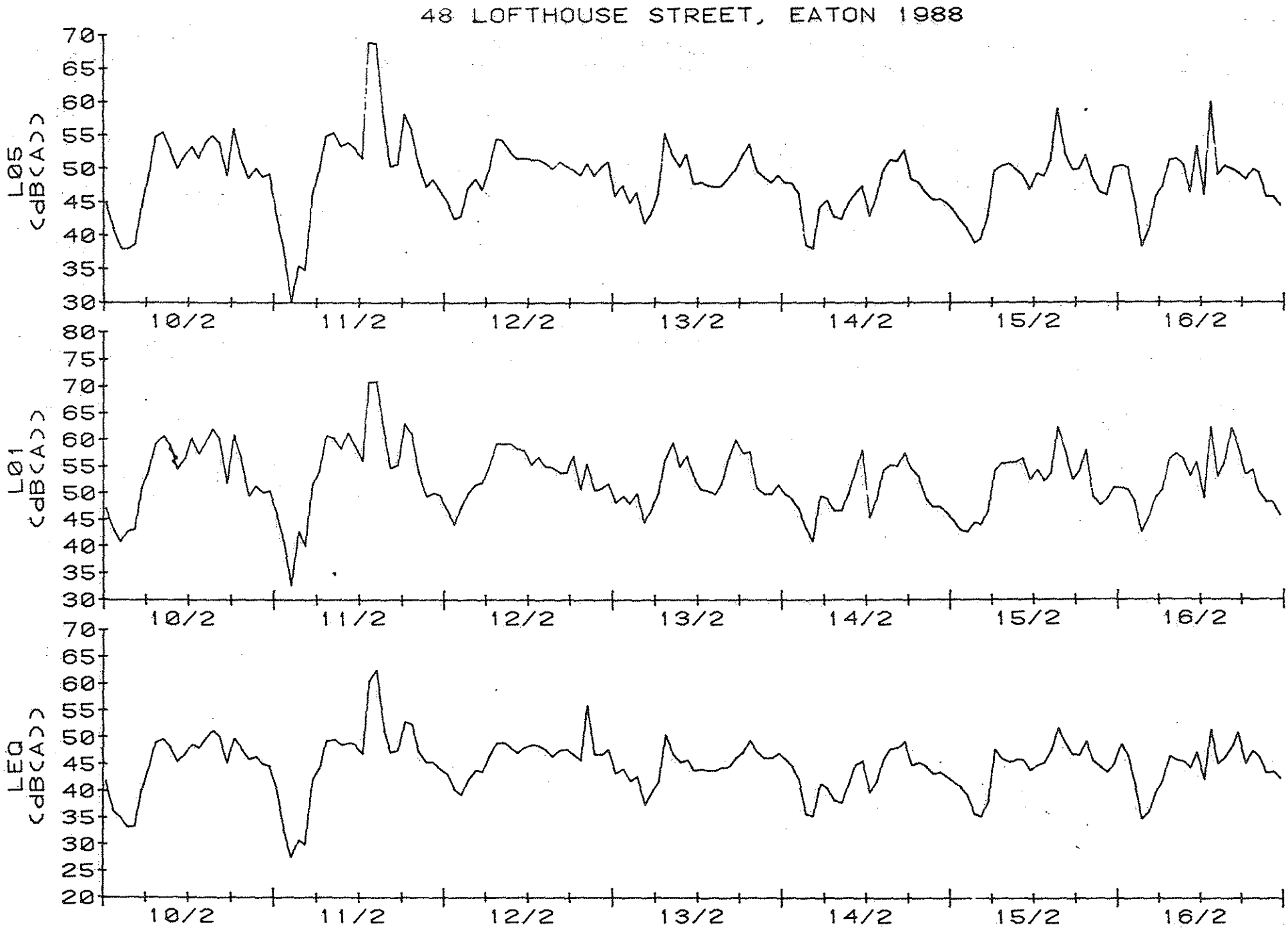
	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
21/02/88									
100	40.0	45.8	43.5	42.5	41.0	39.3	37.5	37.0	35.0
200	37.6	45.3	40.8	39.3	38.0	36.5	34.5	34.0	33.3
300	36.4	42.3	39.3	38.3	37.5	36.0	33.8	33.3	32.5
400	32.8	40.8	34.8	34.3	33.3	32.0	30.0	29.5	28.3
500	33.1	39.5	37.8	36.8	34.5	31.8	28.0	27.5	26.8
600	40.5	52.3	44.3	41.5	38.5	35.5	32.5	31.8	30.5
700	39.5	48.3	44.5	42.5	40.0	37.0	34.8	34.3	33.3
800	37.4	45.3	41.8	40.3	38.3	35.5	32.8	32.3	31.3
900	43.2	54.3	50.5	47.0	42.0	36.5	31.8	31.0	30.0
1000	42.0	51.8	47.3	44.8	41.8	38.0	33.3	32.5	31.3
1100	46.2	56.5	50.3	47.3	44.3	40.0	35.3	34.3	32.5
1200	45.6	56.3	49.3	46.0	43.5	40.3	36.0	34.8	33.0
1300	52.1	64.3	55.3	49.0	43.8	39.8	36.8	36.3	35.3
1400	48.5	60.8	53.0	48.5	44.8	41.3	37.5	36.5	33.8
1500	42.1	51.3	44.8	43.3	42.0	40.3	38.3	37.8	36.5
1600	41.0	47.0	43.8	42.8	41.8	40.3	38.5	38.0	37.0
1700	41.1	47.5	43.3	42.0	41.0	39.5	38.3	37.8	37.0
1800	46.1	53.8	46.3	44.5	42.5	39.8	37.8	37.0	35.0
1900	50.1	62.0	53.5	50.3	48.0	45.0	38.5	37.5	35.5
2000	47.9	56.8	51.5	49.5	48.0	46.0	43.8	43.3	42.3
2100	44.5	50.5	47.5	46.3	45.5	44.0	41.8	40.8	38.0
2200	44.4	47.8	46.5	45.8	45.3	44.5	42.5	39.0	36.8
2300	40.2	46.5	44.3	42.8	41.0	39.0	37.3	36.5	35.8
2400	37.7	43.5	39.8	39.3	38.8	37.8	35.0	34.3	32.3

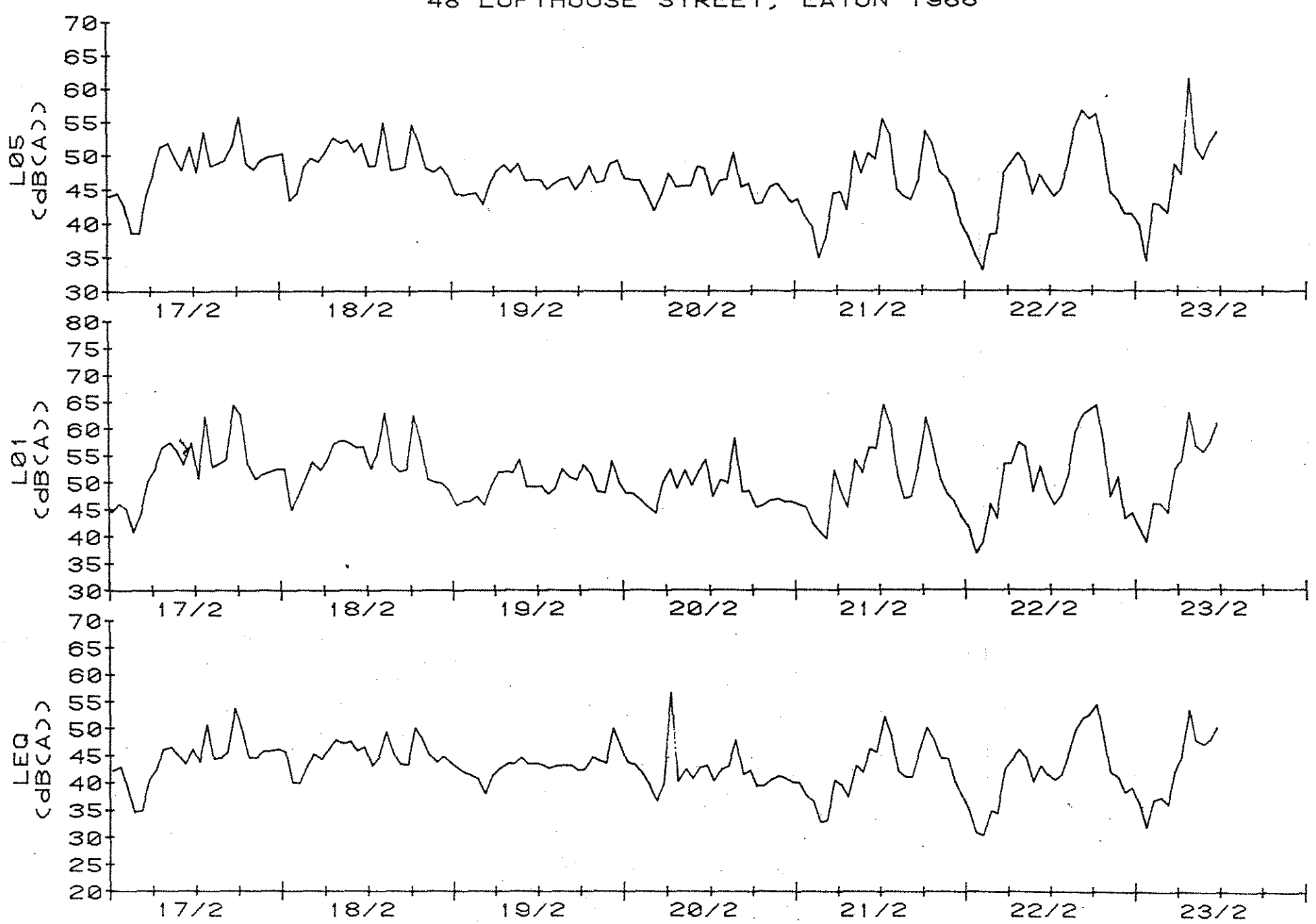
48 LOFTHOUSE STREET, EATON

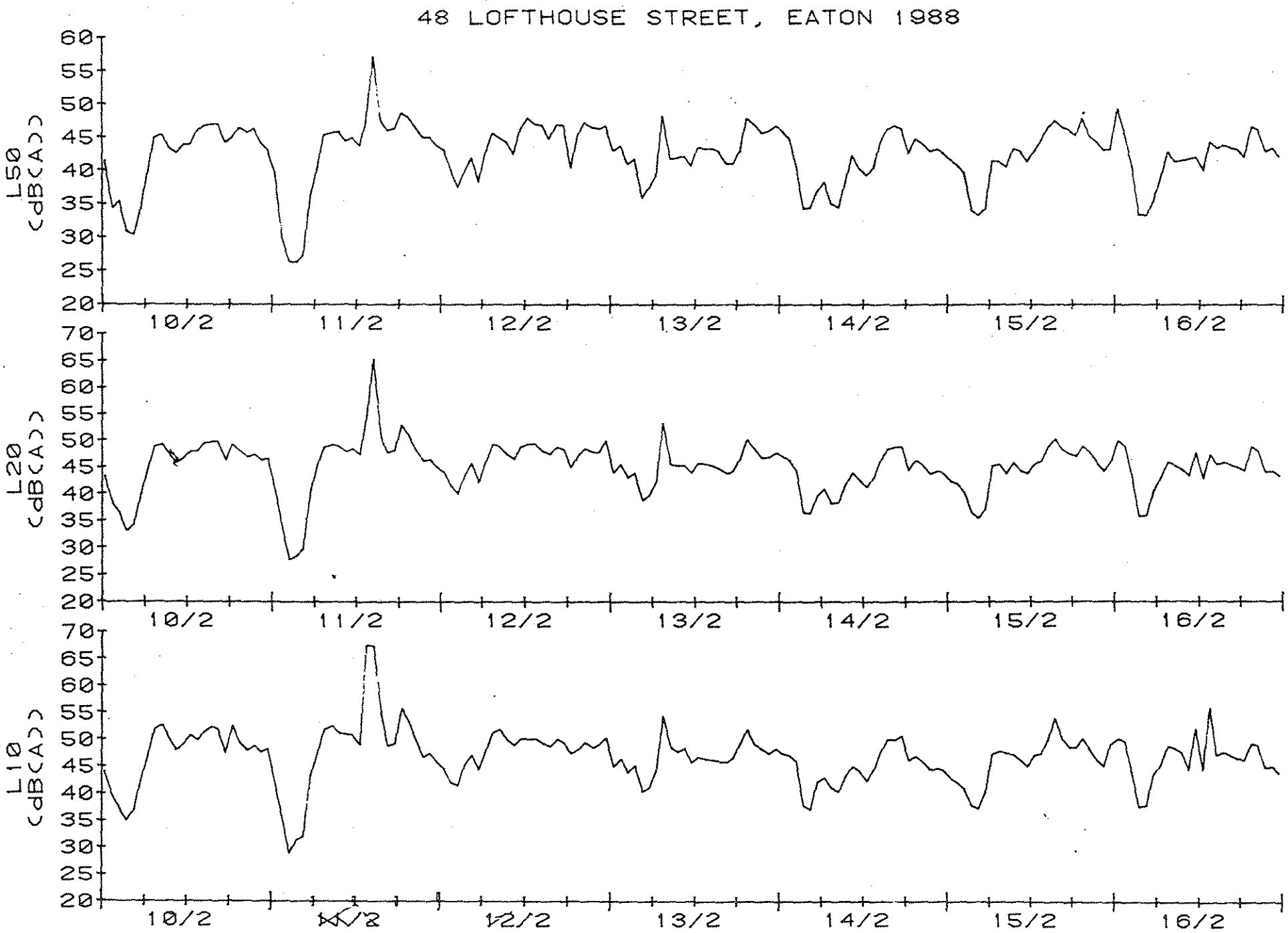
	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
22/02/88									
100	34.5	41.5	37.8	36.8	35.8	34.0	29.3	28.3	27.0
200	30.8	36.8	35.3	34.5	33.3	28.3	26.3	26.3	26.3
300	30.3	38.8	33.0	31.5	30.8	29.3	27.0	26.3	26.3
400	34.8	46.0	38.3	35.0	33.3	30.8	27.8	27.3	26.5
500	34.4	43.3	38.5	37.0	35.3	33.0	29.3	28.8	27.8
600	42.5	53.5	47.3	45.0	42.8	38.5	33.8	33.0	31.3
700	44.2	53.5	48.8	46.8	45.0	42.0	38.5	37.8	36.5
800	46.1	57.5	50.3	47.3	45.5	42.8	39.3	38.3	36.8
900	44.6	56.5	48.8	45.8	43.3	40.0	37.0	36.3	35.5
1000	40.2	48.3	44.3	42.5	40.8	38.3	35.5	35.0	34.0
1100	43.1	53.0	47.0	44.5	42.3	38.8	34.5	33.3	30.5
1200	41.5	48.5	45.3	43.8	42.5	40.3	37.5	36.8	35.5
1300	40.4	45.8	43.8	42.8	41.8	40.0	37.3	36.5	35.0
1400	41.5	47.5	45.0	43.8	42.5	40.8	38.3	37.5	36.8
1500	45.3	51.3	48.5	47.3	46.0	44.3	42.5	41.8	39.3
1600	49.7	59.5	54.0	51.3	48.3	45.5	43.5	43.0	41.8
1700	51.9	62.5	56.5	53.5	50.0	44.3	40.3	39.5	38.0
1800	52.6	63.5	55.3	53.0	51.0	47.5	44.3	41.3	38.5
1900	54.3	64.3	56.0	53.0	50.3	47.0	44.3	43.5	41.8
2000	48.2	57.3	51.5	49.3	47.3	45.5	42.5	42.0	41.3
2100	41.9	47.3	44.5	43.5	42.8	41.5	40.3	40.0	39.3
2200	41.1	51.0	43.3	42.0	41.0	39.5	36.3	35.8	35.0
2300	38.3	43.3	41.3	40.8	39.8	38.0	35.3	34.8	34.3
2400	39.2	44.3	41.3	40.8	40.0	39.0	37.5	37.0	36.0

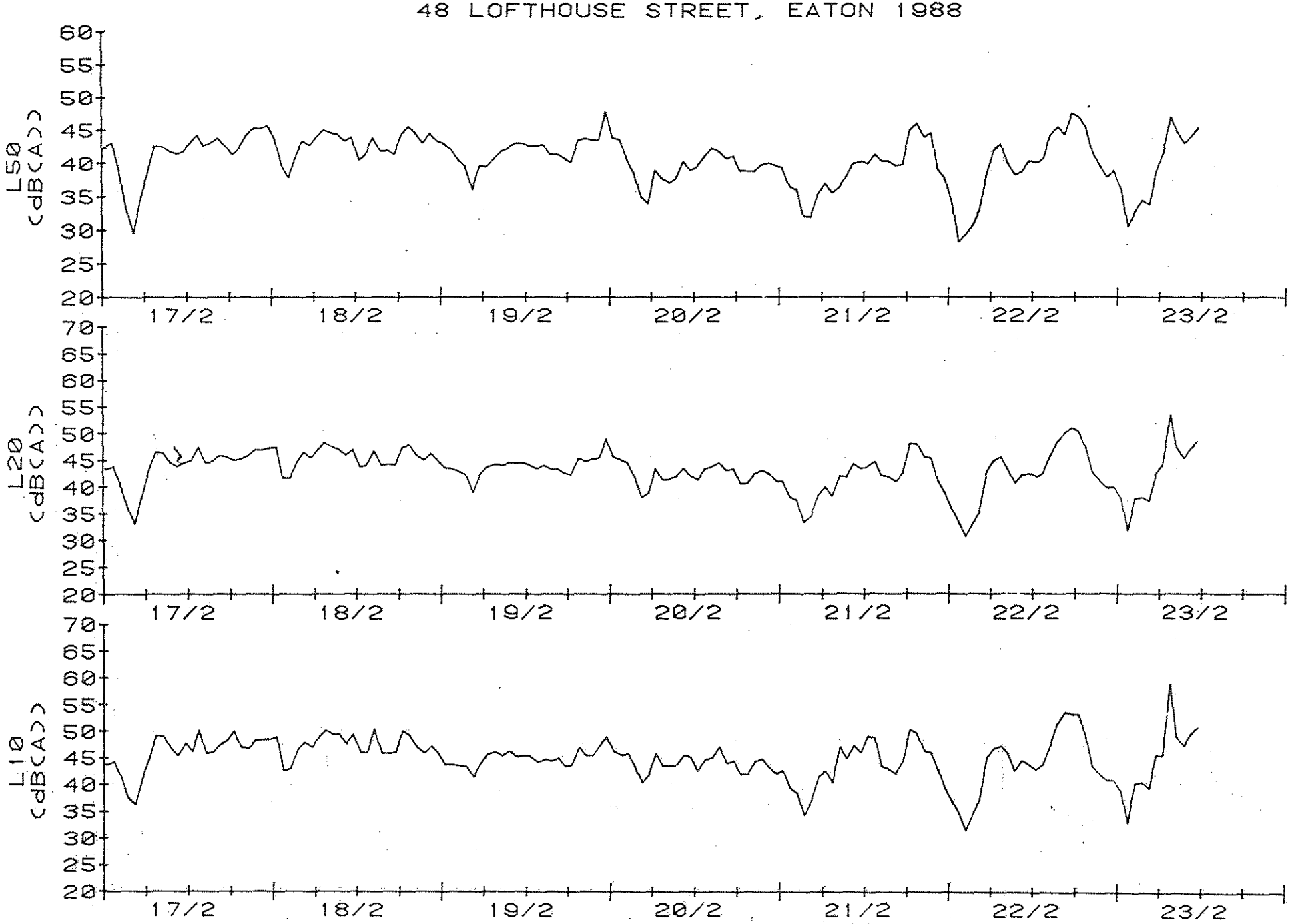
48 LOFTHOUSE STREET, EATON

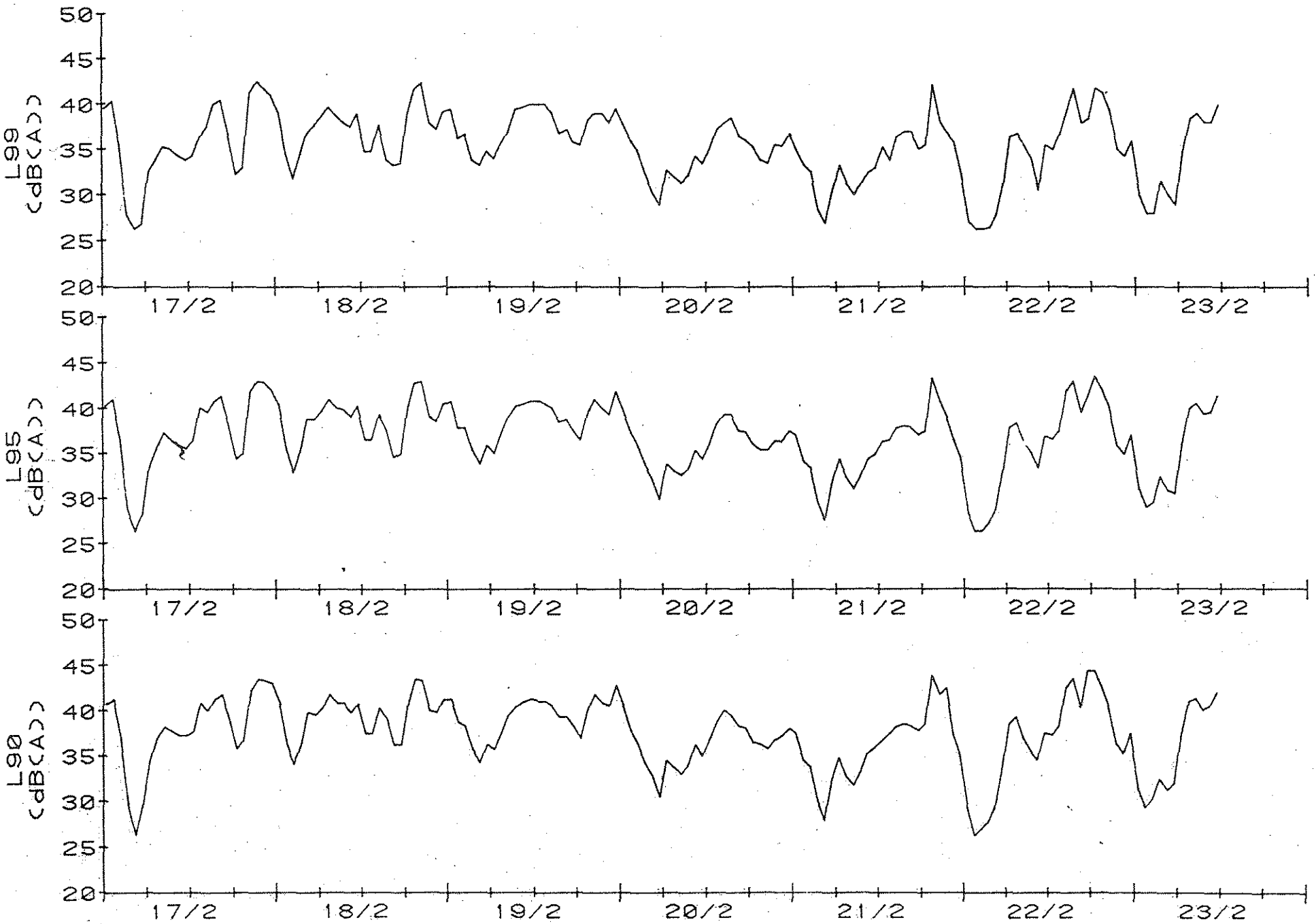
	LEQ	L01	L05	L10	L20	L50	L90	L95	L99
23/02/88									
100	36.0	41.3	39.5	38.8	37.8	36.0	31.3	31.0	30.0
200	31.9	38.8	34.3	33.0	31.8	30.5	29.3	29.0	28.0
300	36.8	46.0	42.8	40.3	37.8	32.8	30.3	29.5	28.0
400	37.3	46.0	42.5	40.5	38.0	34.5	32.5	32.3	31.5
500	36.0	44.3	41.3	39.3	37.3	33.8	31.3	30.8	30.0
600	42.1	52.5	48.5	45.5	42.5	38.8	32.0	30.5	29.0
700	45.0	54.0	47.0	45.5	44.3	41.5	37.3	36.0	34.5
800	53.4	63.0	61.3	58.8	53.5	47.0	41.0	40.0	38.5
900	47.7	56.8	51.0	49.0	47.3	44.8	41.3	40.5	39.0
1000	47.0	55.5	49.3	47.3	45.3	43.0	40.0	39.3	38.0
1100	47.9	57.5	51.8	49.5	47.3	44.0	40.5	39.5	38.0
1200	50.0	61.0	53.3	50.8	48.5	45.3	42.0	41.3	40.0
1300	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1400	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1500	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1600	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1700	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1800	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
1900	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
2000	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
2100	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
2200	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
2300	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0
2400	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0	-99.0

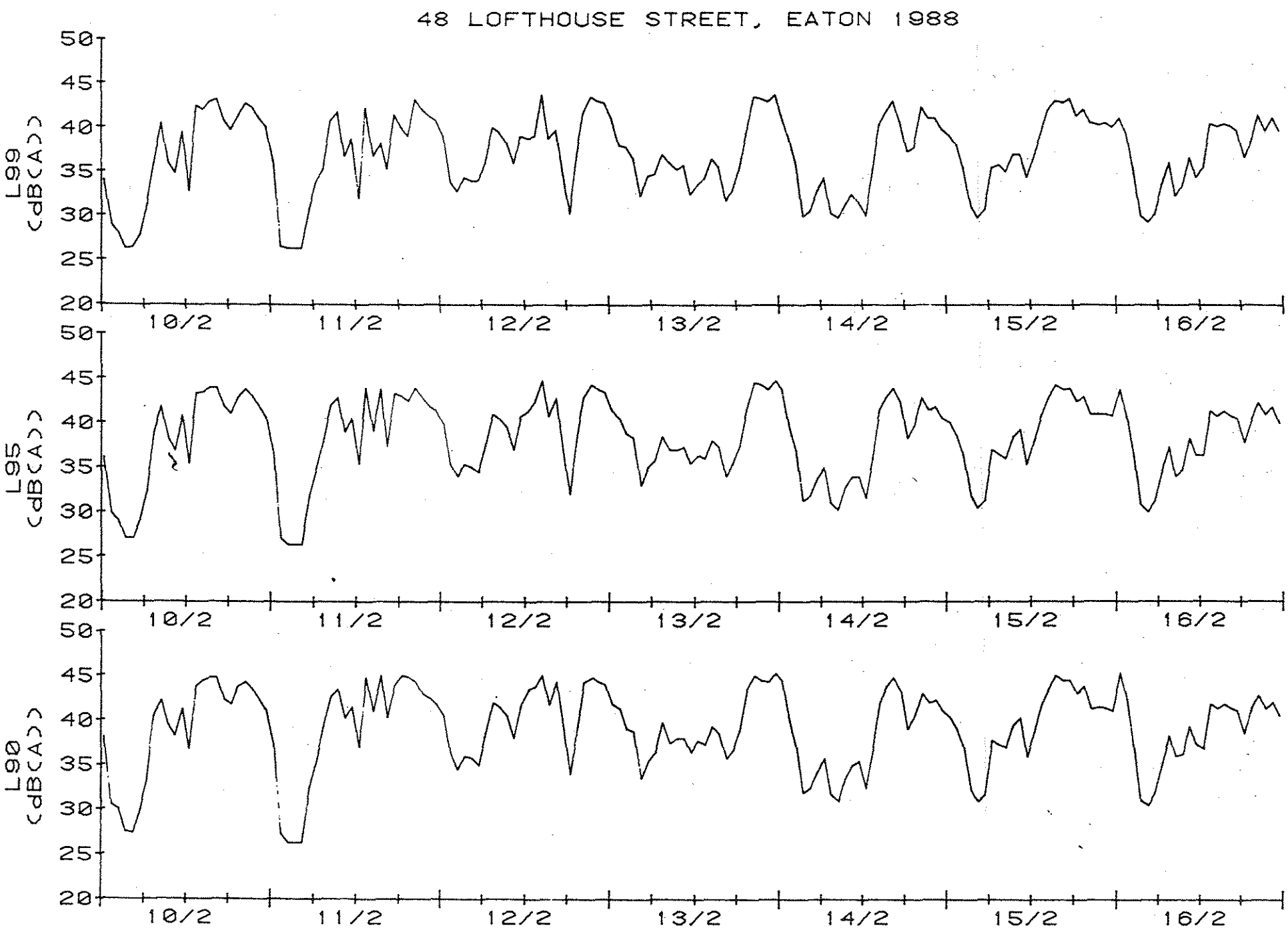

48 LOFTHOUSE STREET, EATON 1988
L05 (dB(A))
L01 (dB(A))
LEQ (dB(A))
70
65
60
55
50
45
40
35
30
80
75
25
20
10/2
11/2
12/2
13/2
14/2
15/2
16/2


48 LOFTHOUSE STREET, EATON 1988
L05 (dB(A))
L01 (dB(A))
LEQ (dB(A))
17/2
18/2
19/2
20/2
21/2
22/2
23/2


48 LOFTHOUSE STREET, EATON 1988
L50 (dB(A))
L20 (dB(A))
L10 (dB(A))
60
55
50
45
40
35
30
25
20
70
65
60
55
50
45
40
35
30
25
20
10/2
11/2
12/2
13/2
14/2
15/2
16/2


48 LOFTHOUSE STREET, EATON 1988
L50 (dB(A))
L20 (dB(A))
L10 (dB(A))
60
55
50
45
40
35
30
25
20
70
65
60
55
50
45
40
35
30
25
20
17/2
18/2
19/2
20/2
21/2
22/2
23/2


L99
(dB(A))
50
45
40
35
30
25
20
17/2
18/2
19/2
20/2
21/2
22/2
23/2
L95
(dB(A))
50
45
40
35
30
25
20
17/2
18/2
19/2
20/2
21/2
22/2
23/2
L90
(dB(A))
50
45
40
35
30
25
20
17/2
18/2
19/2
20/2
21/2
22/2
23/2


48 LOFTHOUSE STREET, EATON 1988
L99 (dB(A))
L95 (dB(A))
L90 (dB(A))
50
45
40
35
30
25
20
10/2
11/2
12/2
13/2
14/2
15/2
16/2

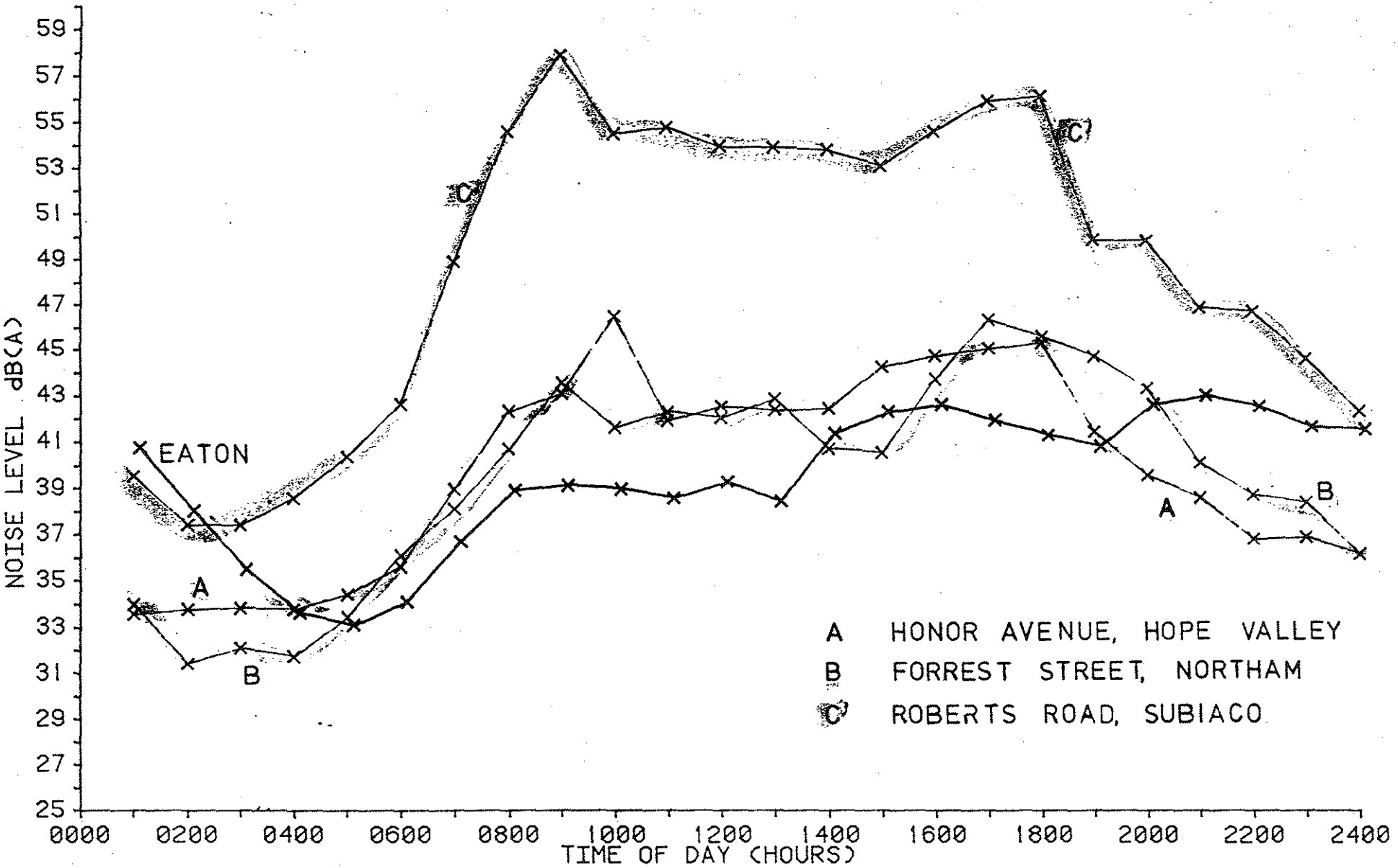
BACKGROUND NOISE LEVEL DATA AT SOME SUBURBAN SITES

BACKGROUND NOISE LEVEL DATA

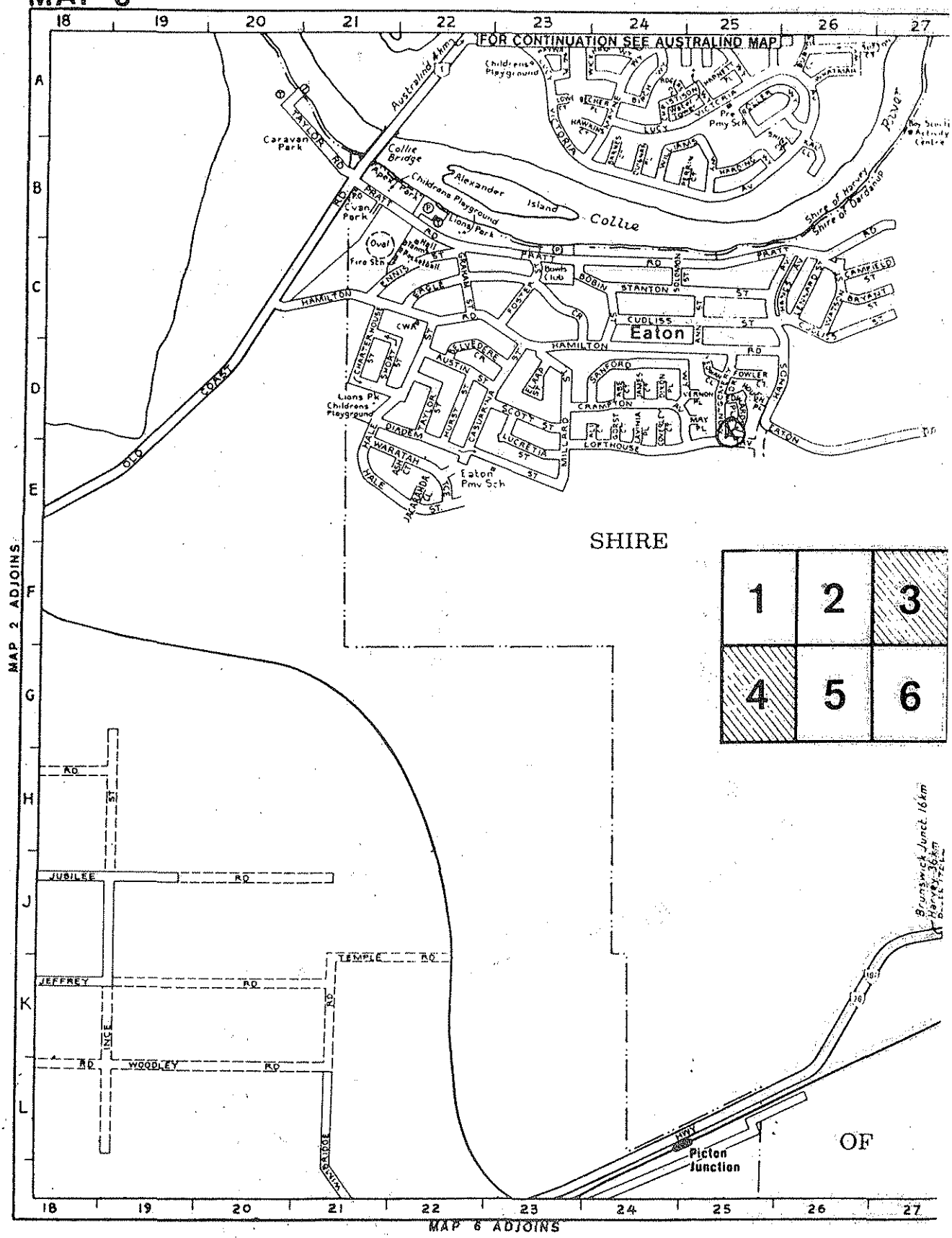
The attached graphs represent background noise level data collected by the Pollution Control Division in the period November 1986 to date at various locations.

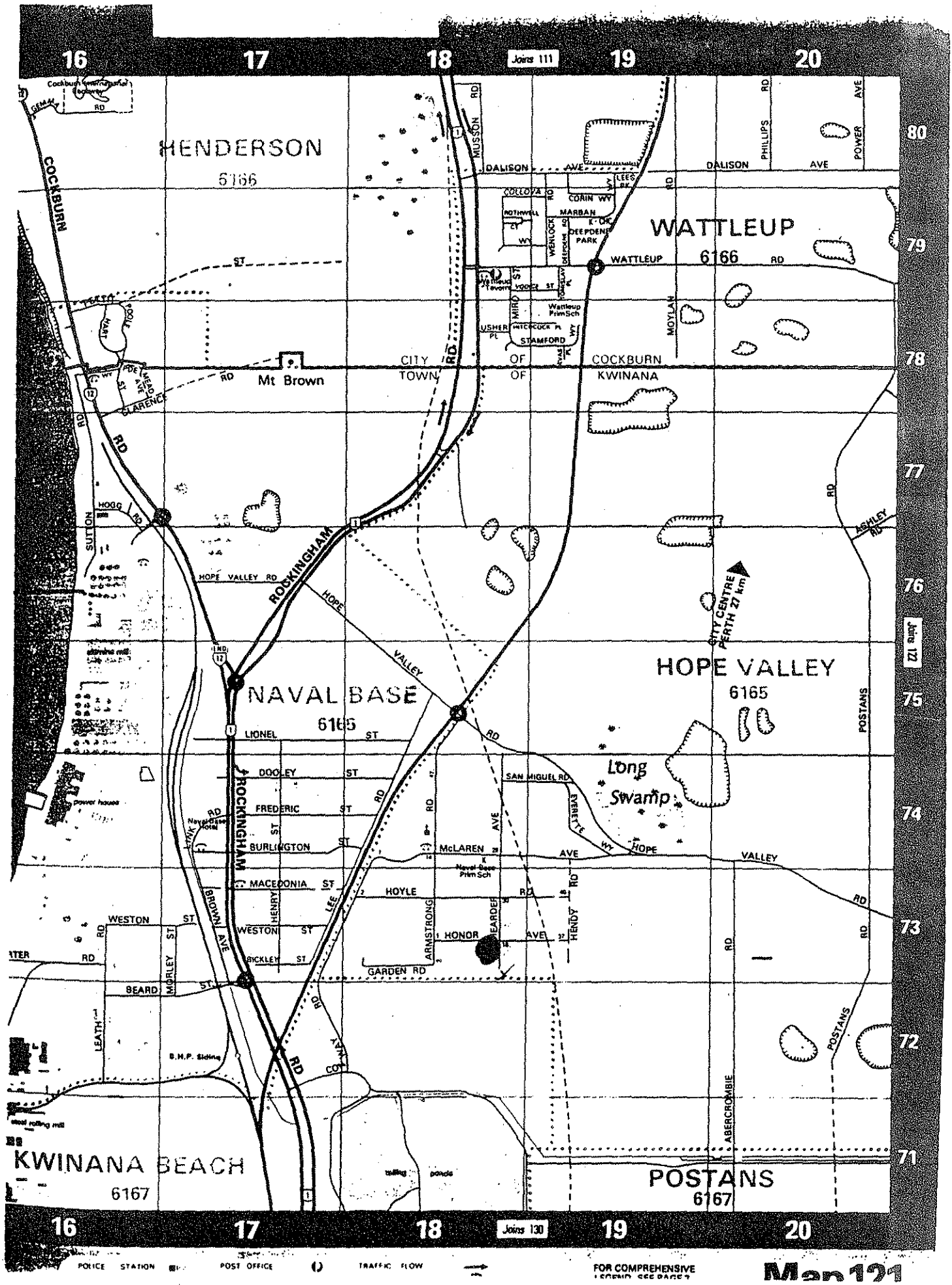
The data plotted represents the average of all L_{90} (background) noise levels for a given hour in the data base held for a given location ie the graphs do not represent the extreme low or extreme high background noise levels measured at the site. Length of measurement periods at each site has varied.

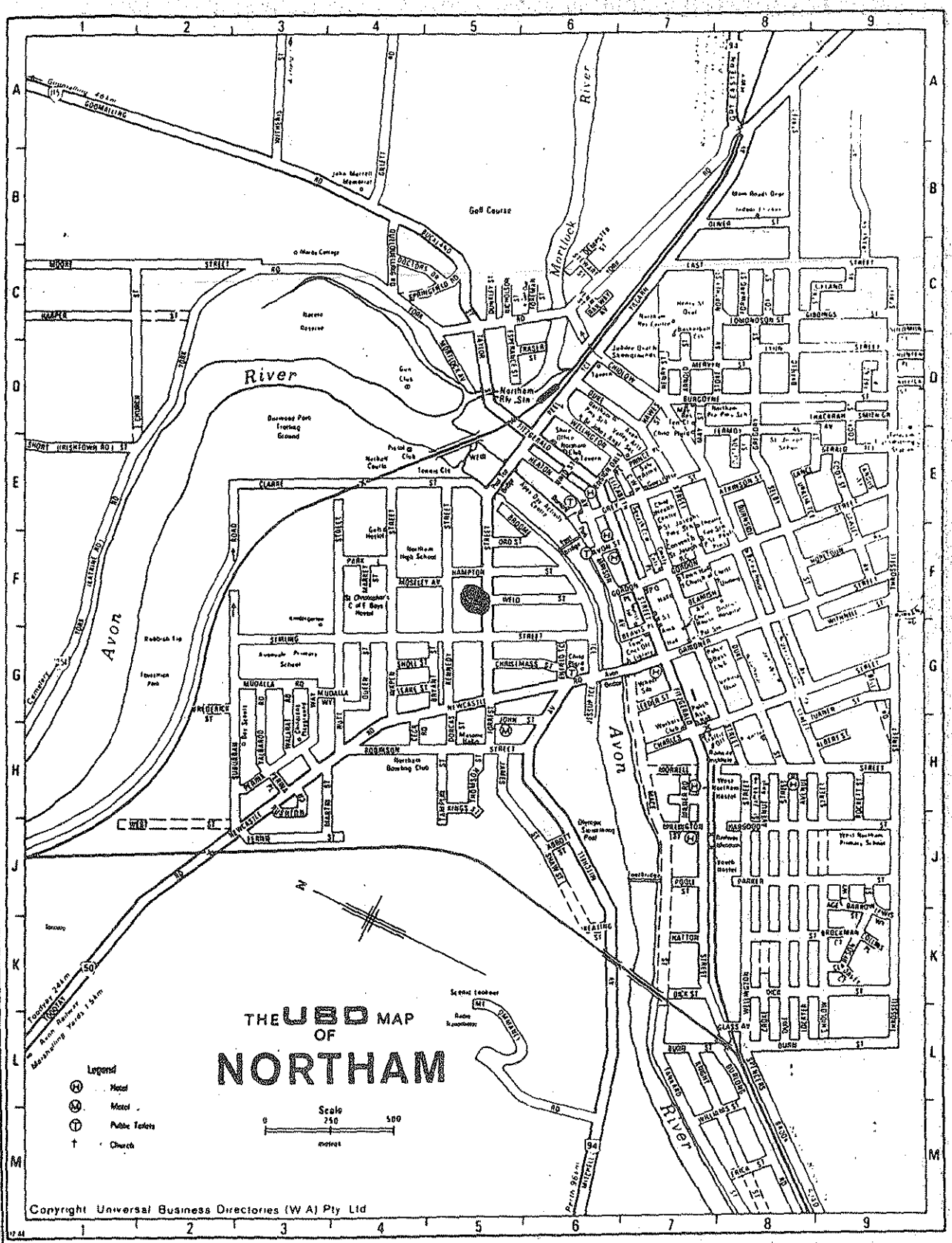
The data for Eaton has been plotted on each occasion for ease of comparison. The graphs demonstrate that Eaton is not an exceptional case in respect of its background noise level; in fact some Perth metropolitan areas demonstrate lower levels.

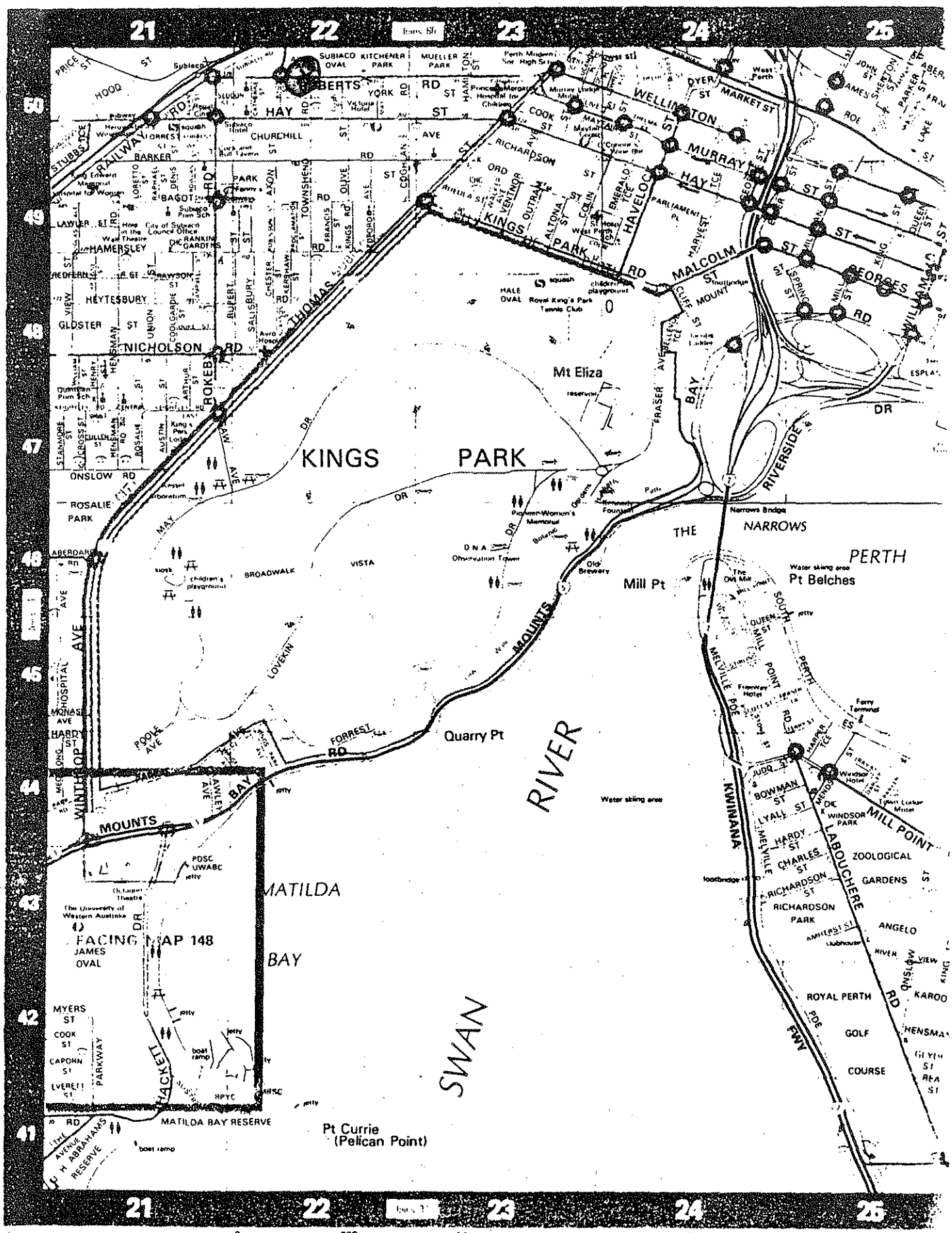

NOISE LEVEL dB(A)
59
57
55
53
51
49
47
45
43
41
39
37
35
33
31
29
27
25
0000
0200
0400
0600
0800
1000
1200
1400
1600
1800
2000
2200
2400
TIME OF DAY (HOURS)
EATON
A
B
C
A HONOR AVENUE, HOPE VALLEY
B FORREST STREET, NORTHAM
C ROBERTS ROAD, SUBIACO

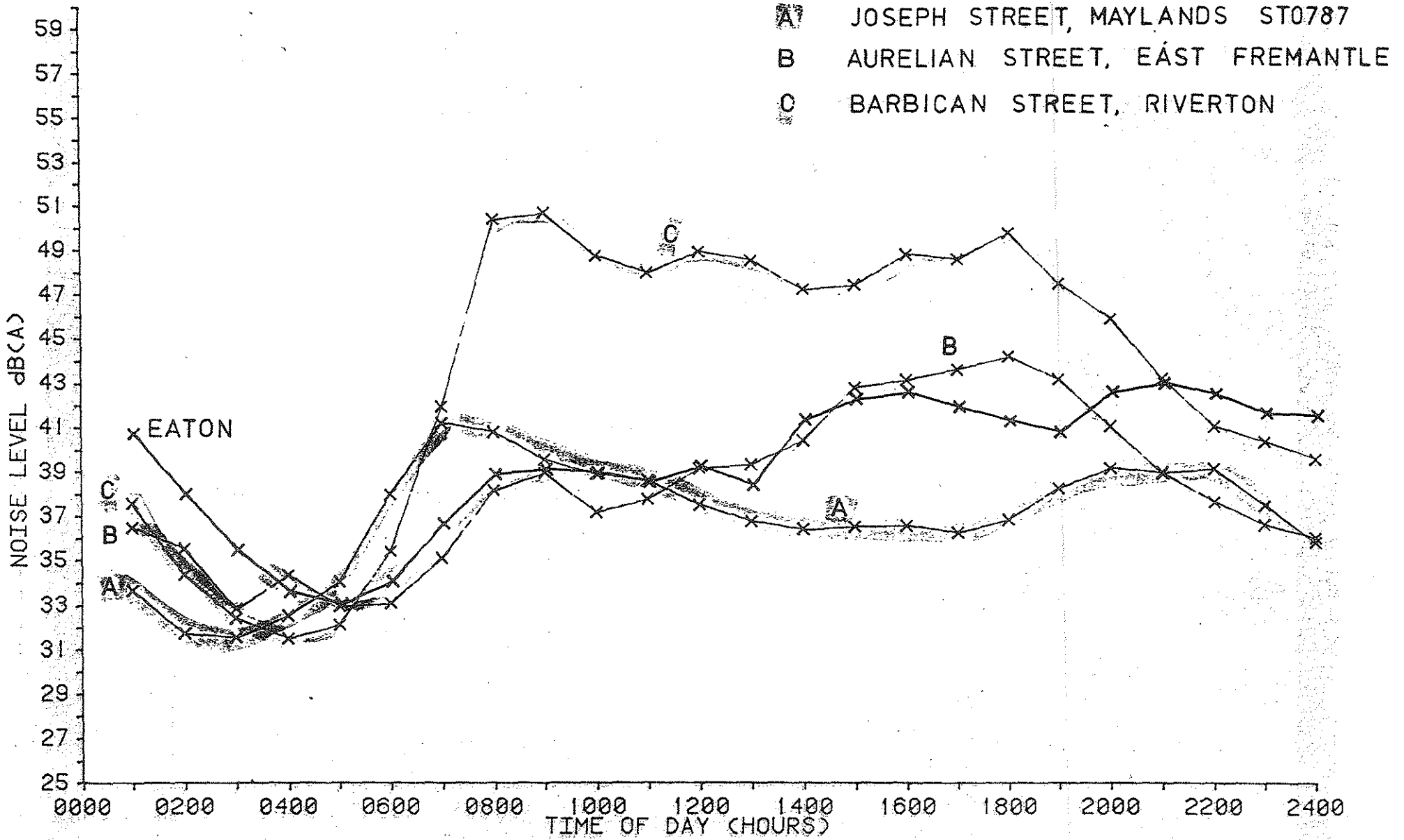
MAP 3

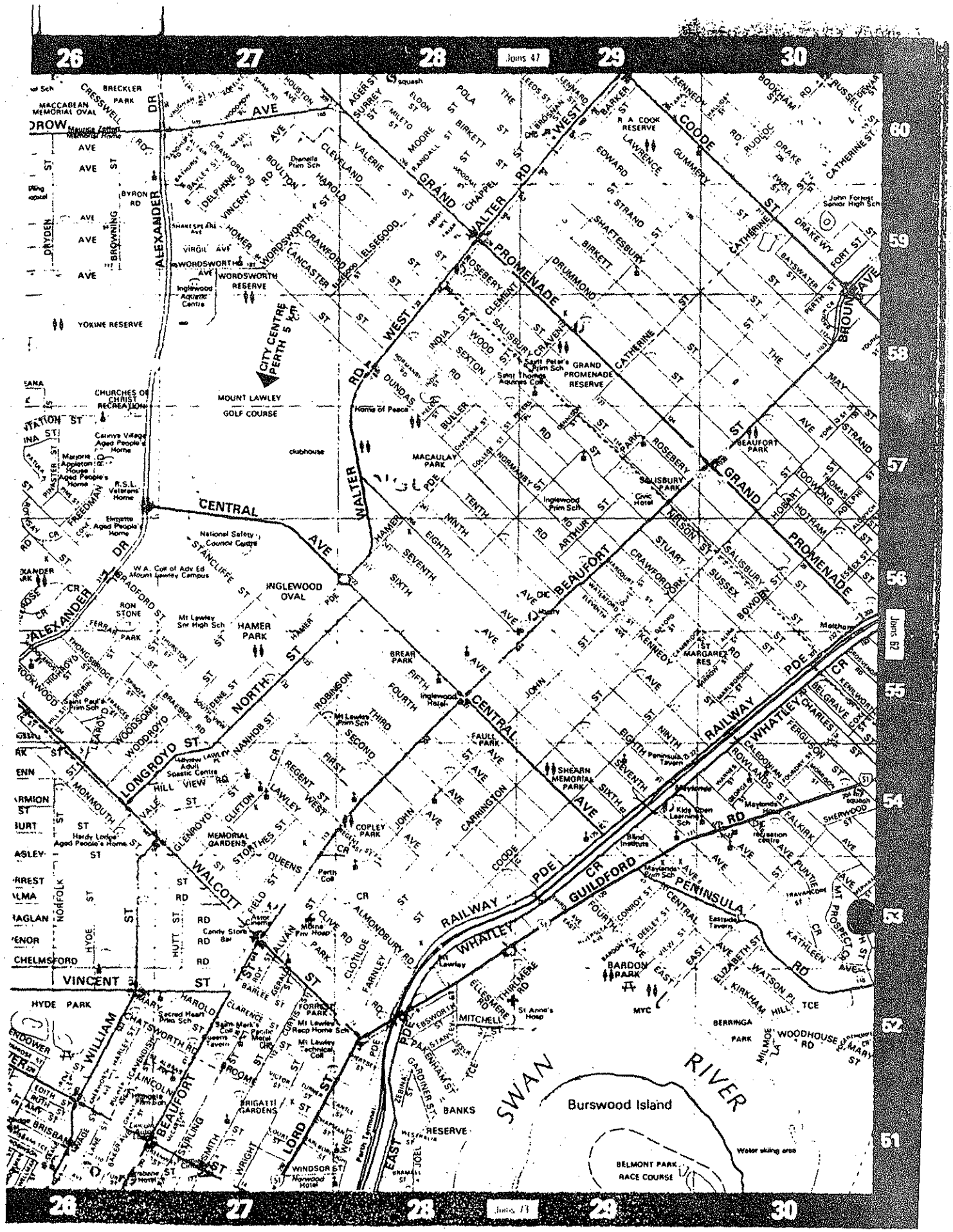

18 19 20 21 22 23 24 25 26 27
A B C D E F G H J K L
FOR CONTINUATION SEE AUSTRALIND MAP
Australind
Collie
Alexander Island
Collie Bridge
Caravan Park
TAYLOR RD
PRATT RD
Lions Park
Oval
Fire Sta
Bowls Club
Childrens Playground
Lions Pk Childrens Playgrnd
Eaton
Eaton Pmy Sch
HAMILTON RD
BOBIN ST
STANTON ST
CUDLISS ST
CRAMPTON
LOFTHOUSE
LUCRETIA ST
DIADEM
WARATAH
HALE
JACARANDA
OLD COAST
EATON
Pre Pmy Sch
SHIRE
OF
MAP 2 ADJOINS
MAP 6 ADJOINS
JUBILEE RD
JEFFREY RD
WOODLEY RD
TEMPLE RD
INGE
Picton Junction
HWY
Brunswick Junct. 16km
Harvey 36km
1 2 3
4 5 6


16
17
18
Joins 111
19
20
80
79
78
77
76
75
74
73
72
71
Joins 121
Joins 130
HENDERSON
6166
WATTLEUP
6166
CITY OF COCKBURN
TOWN OF KWINANA
NAVAL BASE
6165
HOPE VALLEY
6165
KWINANA BEACH
6167
POSTANS
6167
COCKBURN RD
MUSSON RD
DALISON AVE
PHILLIPS AVE
POWER AVE
WATTLEUP RD
MOYLAN
Wattleup PrimSch
STAMFORD
Mt Brown
CLARENCE
HOGG RD
SUTTON
ROCKINGHAM
HOPE VALLEY RD
HOPE VALLEY
ASHLEY RD
CITY CENTRE PERTH 27 km
POSTANS
LIONEL ST
DOOLEY ST
FREDERIC ST
BURLINGTON ST
MACEDONIA ST
WESTON ST
BICKLEY ST
BEARD ST
MORLEY ST
BROWN AVE
HENRY
LEE
ARMSTRONG
EARDLEY
HENDY
SAN MIGUEL RD
EVERETT
McLAREN AVE
HOYLE RD
HONOR AVE
GARDEN RD
Long Swamp
Naval Base PrimSch
ABERCROMBIE
LEATH
COCKBURN
POLICE STATION
POST OFFICE
TRAFFIC FLOW
FOR COMPREHENSIVE


THE UBD MAP OF NORTHAM
Legend
Hotel
Motel
Public Toilets
Church
Scale
0 250 500
metres
Avon
River
Northam Rly Stn
Northam High School
Northam Bowling Club
Copyright Universal Business Directories (W A) Pty Ltd


21
22
23
24
25
49
48
47
46
45
44
43
42
41
KINGS PARK
Mt Eliza
Mill Pt
Quarry Pt
Pt Belches
Pt Currie
(Pelican Point)
THE NARROWS
PERTH
RIVER
SWAN
BAY
MATILDA BAY
FACING MAP 148
MATILDA BAY RESERVE
JAMES OVAL
ROSALIE PARK
HALE OVAL
ZOOLOGICAL GARDENS
RICHARDSON PARK
ROYAL PERTH GOLF COURSE
WINDSOR PARK
MILL POINT
HAY ST
ST GEORGES TCE
MOUNTS BAY RD
RIVERSIDE DR
KINGS PARK RD
ONSLOW RD
NICHOLSON RD
FORREST RD
THOMAS ST
ROKEBY RD
RAILWAY PDE
STUBBS TCE
WELLINGTON ST
MURRAY ST
MARKET ST
HAVELOCK ST
COOK ST
RICHARDSON ST
MALCOLM ST
BARKER RD
HAMERSLEY
HEYTESBURY
GLOSTER ST
BAGOT
CHURCHILL AVE
YORK RD
ROBERTS RD
SUBIACO OVAL
KITCHENER PARK
MUELLER PARK
HOOD ST
PRICE ST
BROADWALK
VISTA
DNA Observation Tower
Old Brewery
Narrows Bridge
Water skiing area
Ferry Terminal
Footbridge
PDSC UWABC
HPYC
RRSC
boat ramp
jetty
Scale 0 500 m 1 km 2 km
PRIMARY RECTANGLE
Map 72

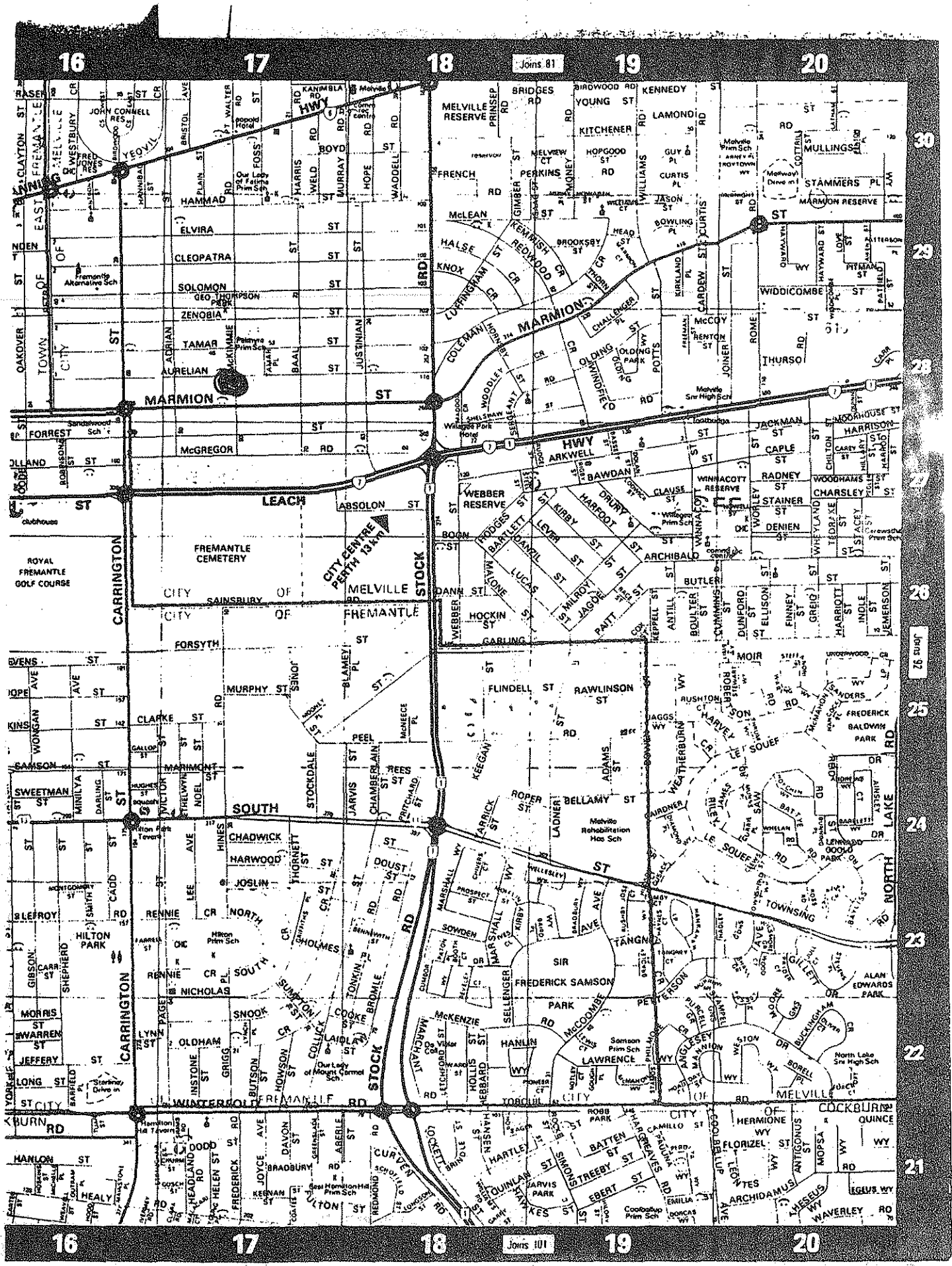

A JOSEPH STREET, MAYLANDS ST0787
B AURELIAN STREET, EAST FREMANTLE
C BARBICAN STREET, RIVERTON
EATON
NOISE LEVEL dB(A)
TIME OF DAY (HOURS)
59
57
55
53
51
49
47
45
43
41
39
37
35
33
31
29
27
25
0000
0200
0400
0600
0800
1000
1200
1400
1600
1800
2000
2200
2400

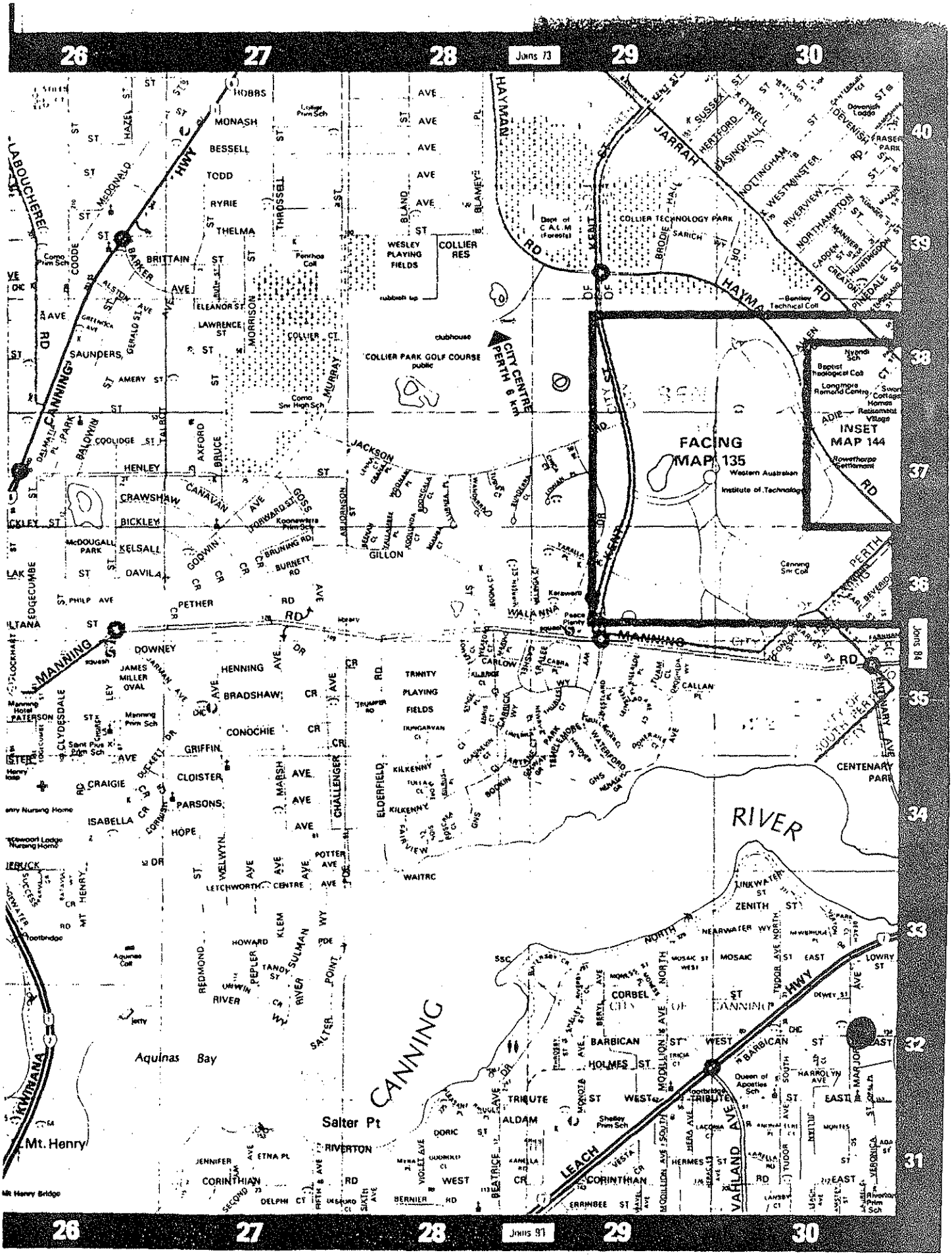


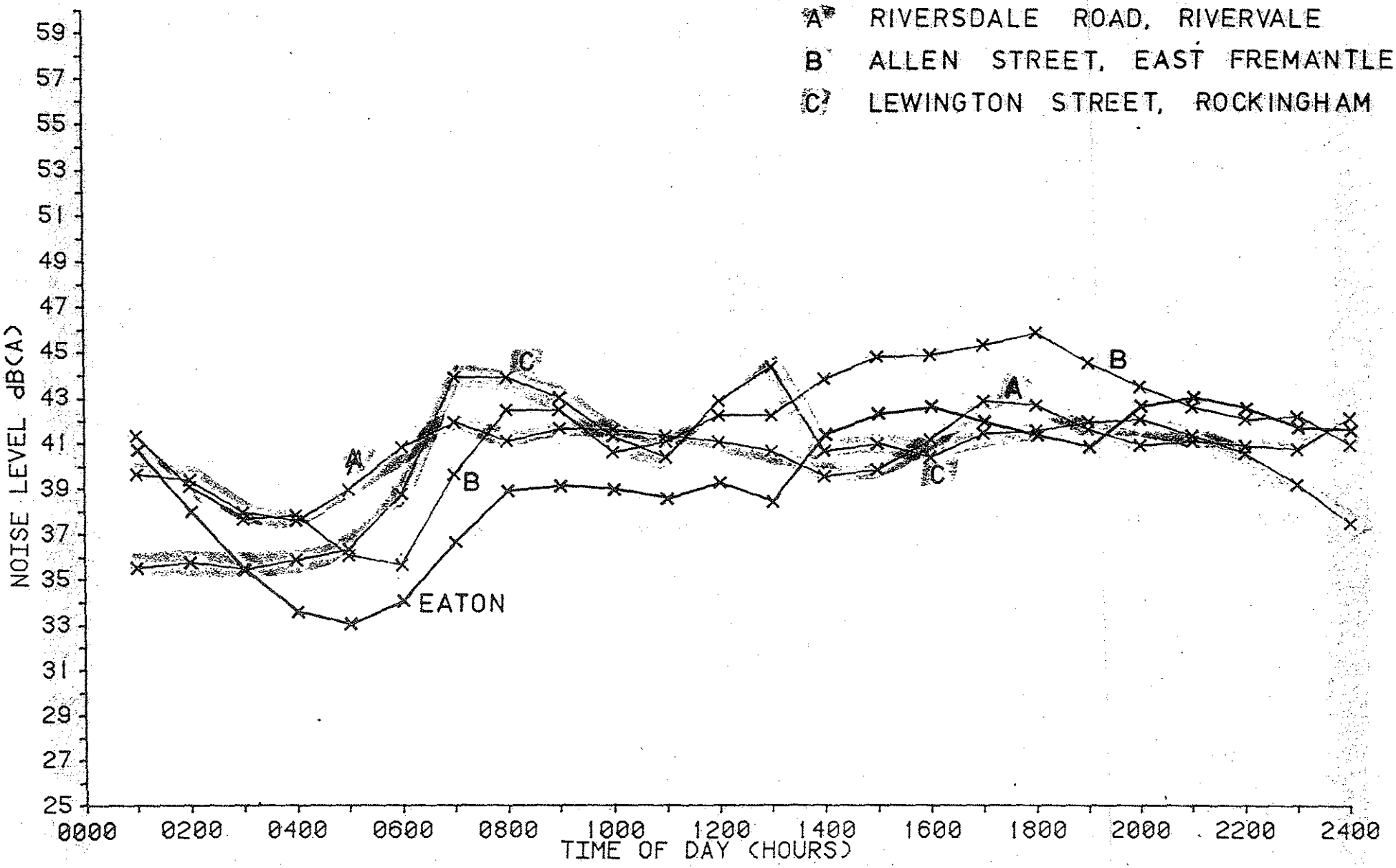
POLICE STATION POST OFFICE TRAFFIC FLOW

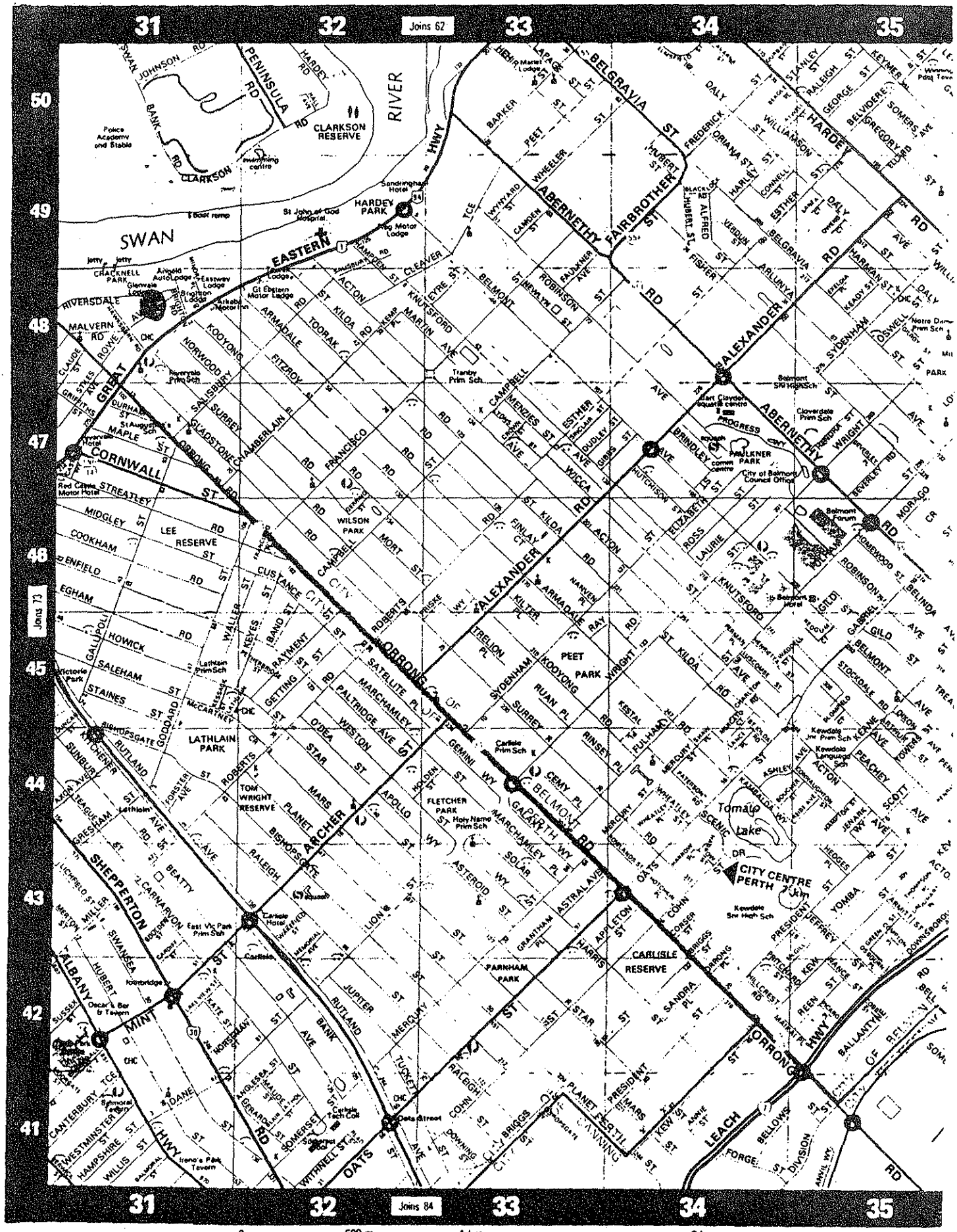
FOR COMPREHENSIVE LEGEND, SEE PAGE 3

Map 61


16
17
18
Joins 81
19
20
Joins 101
Joins 92
MARMION
LEACH
HWY
CARRINGTON
STOCK
SOUTH
NORTH
MELVILLE
FREMANTLE
CITY OF FREMANTLE
CITY OF MELVILLE
CITY CENTRE PERTH 13 km
FREMANTLE CEMETERY
ROYAL FREMANTLE GOLF COURSE
MELVILLE RESERVE
WEBBER RESERVE
WINNACOTT RESERVE
FREDERICK SAMSON PARK
HILTON PARK
Melville Rehabilitation Hos Sch
Melville Snr High Sch
North Lake Snr High Sch
Samson Prim Sch
Coolbellup Prim Sch
Palmyra Prim Sch
Fremantle Alternative Sch
Hilton Park Tavern
Hamilton Hill Tavern
POLICE STATION
POST OFFICE
TRAFFIC FLOW
FOR COMPREHENSIVE
Map 01

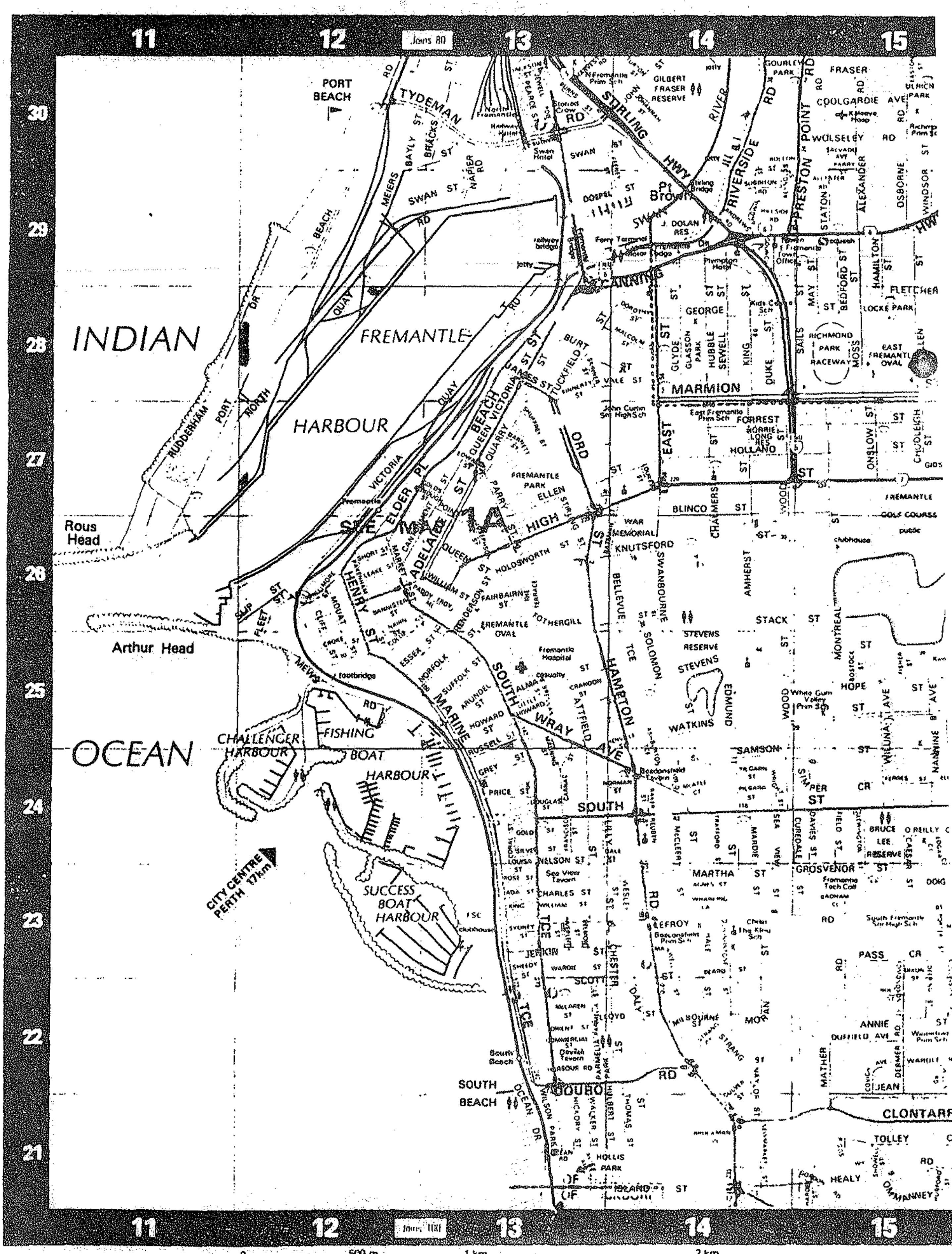

26
27
28
Joins 73
29
30
Joins 84
Joins 91
31
32
33
34
35
36
37
38
39
40
FACING MAP 135
INSET MAP 144
CANNING HWY
MANNING RD
HAYMAN RD
JARRAH RD
KENT ST
CITY CENTRE PERTH 6 KM
COLLIER PARK GOLF COURSE
COLLIER TECHNOLOGY PARK
Western Australian Institute of Technology
Canning Sm Coll
Como Sm High Sch
Penrhos Coll
Bentley Technical Coll
Manning Prim Sch
Koongamia Prim Sch
Aquinas Coll
Mt Henry Bridge
RIVER
CANNING
Aquinas Bay
Salter Pt
Mt. Henry
HOBBS
MONASH
BESSELL
TODD
RYRIE
THELMA
BRITTAIN
SAUNDERS
LAWRENCE
ELEANOR
COLLIER CT
HENLEY
CRAWSHAW
BICKLEY
KELSALL
DAVILA
GILLON
WALANNA
PETHER
DOWNEY
HENNING
BRADSHAW
CONOCHIE
GRIFFIN
CLOISTER
PARSONS
HOPE
CRAIGIE
ISABELLA
JAMES MILLER OVAL
TRINITY PLAYING FIELDS
WESLEY PLAYING FIELDS
COLLIER RES
CENTENARY PARK
LINKWATER
ZENITH
NEARWATER
MOSAIC
CORBEL
BARBICAN
HOLMES
TRIBUTE
ALDAM
RIVERTON
CORINTHIAN
LEACH
VARLAND AVE


A RIVERSDALE ROAD, RIVERVALE
B ALLEN STREET, EAST FREMANTLE
C LEWINGTON STREET, ROCKINGHAM
NOISE LEVEL dB(A)
59
57
55
53
51
49
47
45
43
41
39
37
35
33
31
29
27
25
0000
0200
0400
0600
0800
1000
1200
1400
1600
1800
2000
2200
2400
TIME OF DAY (HOURS)
EATON



Map 74

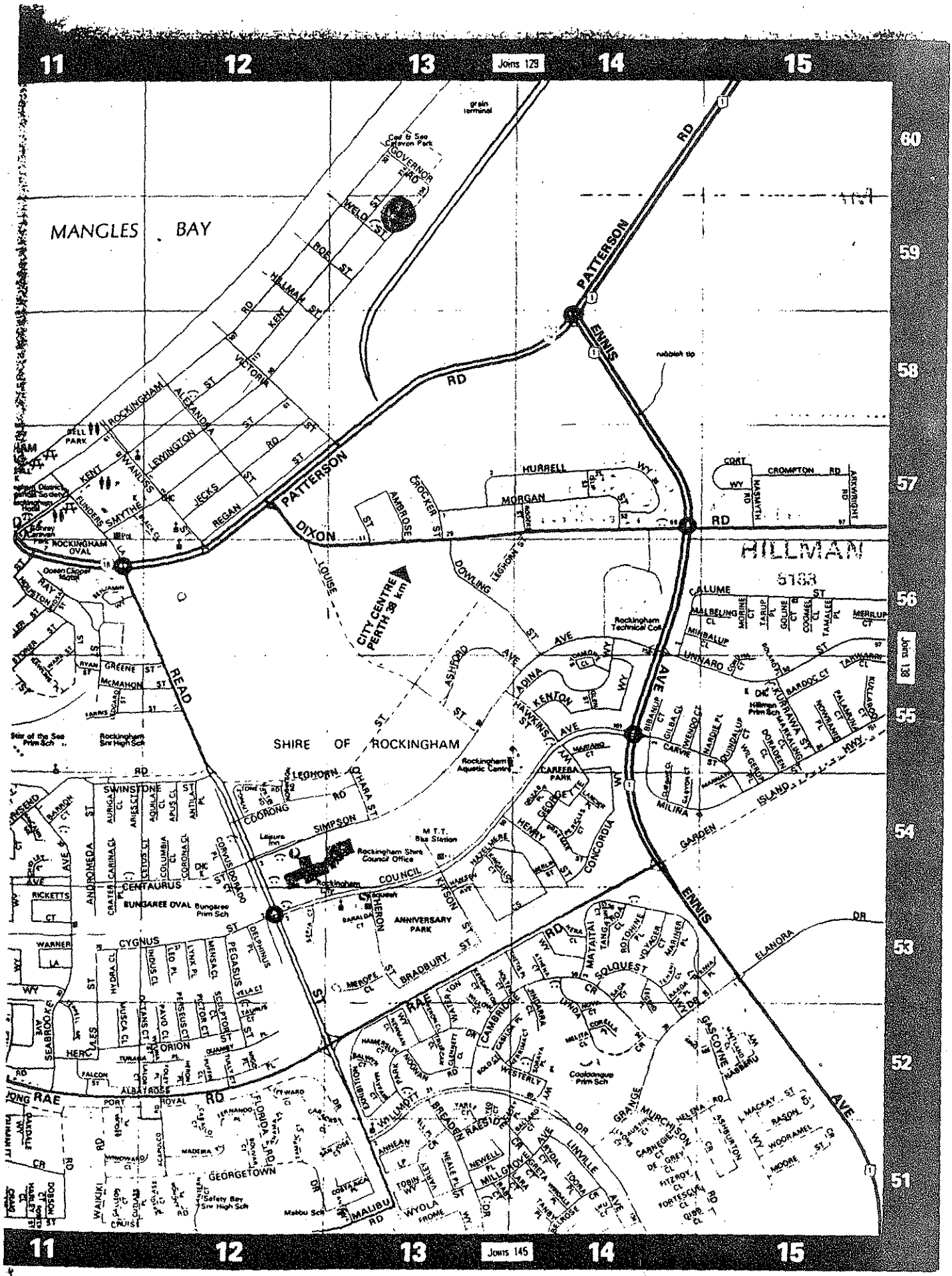
PRIMARY RECTANGLE
PERTH RG 74

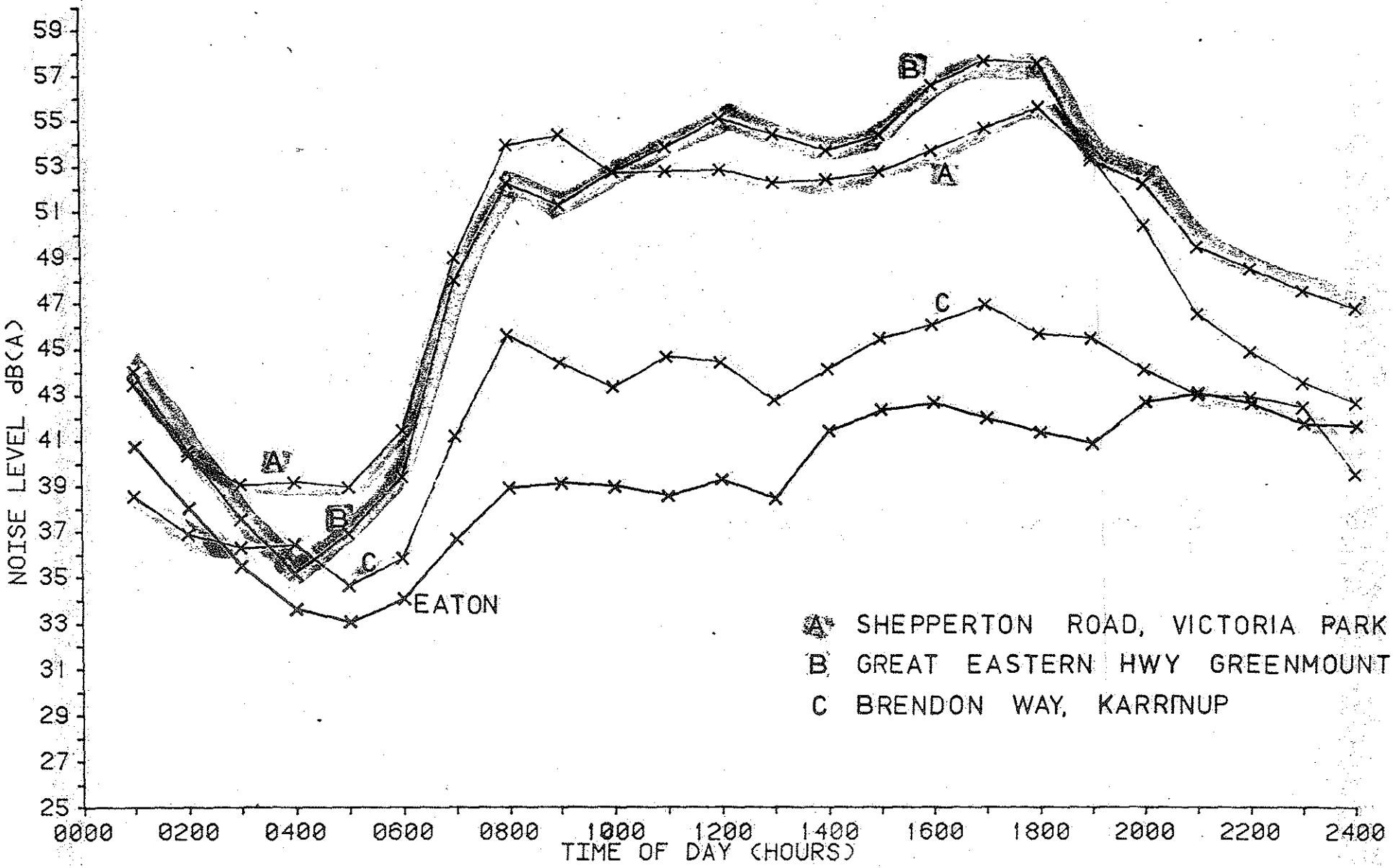


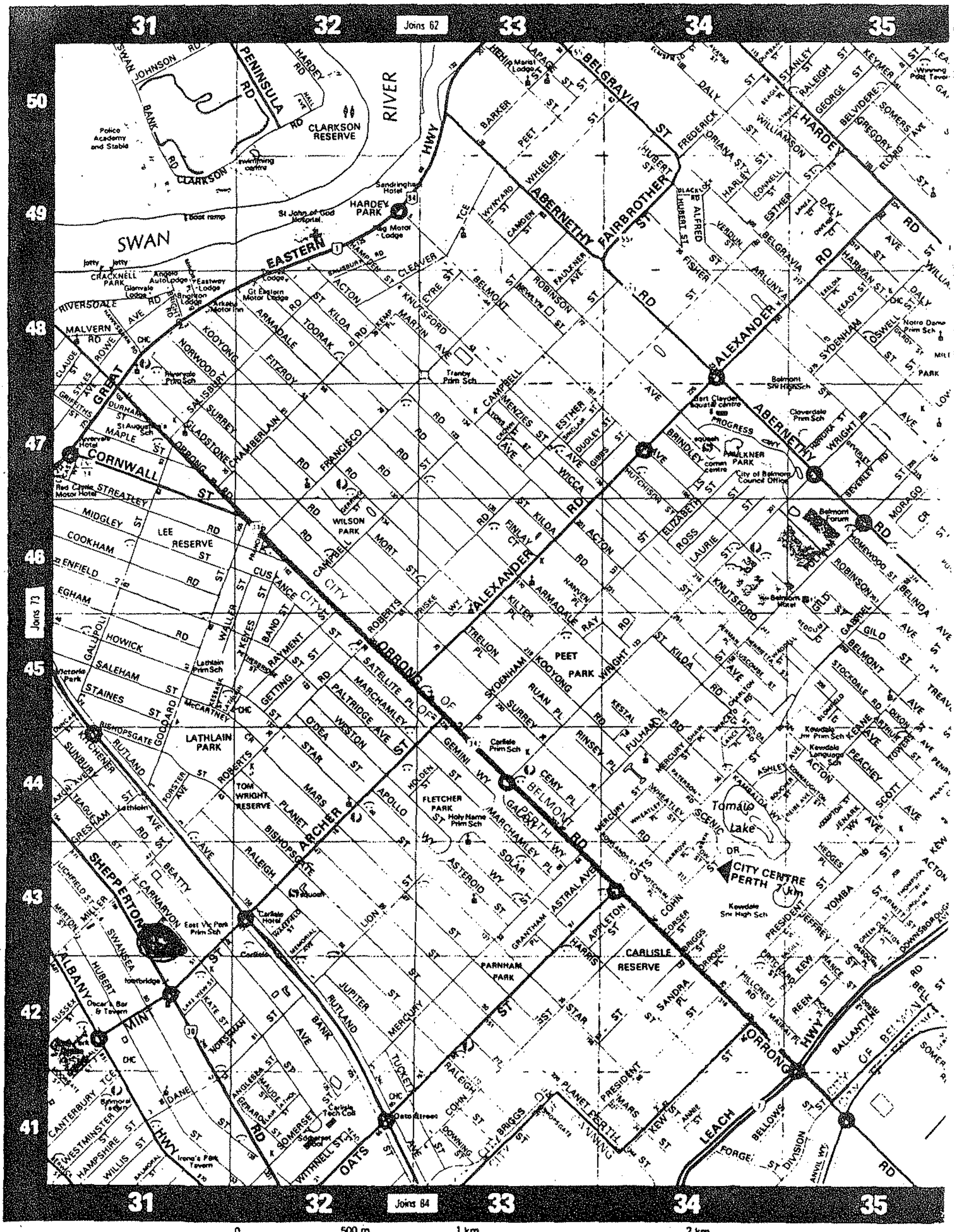
Map 90

0 500 m 1 km 2 km

PRIMARY RECTANGLE


11
12
13
Joins 129
14
15
80
59
58
57
56
55
54
53
52
51
Joins 138
Joins 145
MANGLES BAY
PATTERSON RD
ENNIS RD
HILLMAN
5183
SHIRE OF ROCKINGHAM
CITY CENTRE PERTH 38 km
ROCKINGHAM OVAL
BELL PARK
BUNGAREE OVAL
ANNIVERSARY PARK
Rockingham Shire Council Office
Rockingham Technical Coll
Rockingham Aquatic Centre
Coolongup Prim Sch
Safety Bay Snr High Sch
Star of the Sea Prim Sch
Rockingham Snr High Sch
Leisure Inn
M.T.T. Bus Station
rubbish tip
grain terminal
Cod & Sea Aquarium Perth
GEORGETOWN
ROCKINGHAM
ALEXANDRA
LEWINGTON
KENT
SWANBOURNE
RUNDERS
SMYTHE
JECKS
REGAN
VICTORIA
HILLMAN
ROE ST
KELLO ST
GOVERNOR
HURRELL
MORGAN
CROCKER
AMBROSE
DIXON
LOUISE
DOWLING
LEIGHORN
ASHFORD
ADINA
KENTON
HAWKINS
CALUME
MALBELING
MINBALUP
LUNNARO
TAMWARRIN
BARDOC
KURRAWA
MILINA
GARDEN ISLAND HWY
CRMT
CROMPTON RD
READ
GREENE
McMAHON
RYAN
HOUSTON
HAY
LEGHORN
O'HARA
COORONG
SIMPSON
CAREEBA PARK
GEORGETTE
HENRY
CONCORDIA
SWINSTONE
AURIGA
ARIES
AQUILA
APUS
ANTLIA
ANDROMEDA
CENTAURUS
RICKETTS
CRATER
CARINA
COLUMBIA
CORONA
CORVUS
DORADO
CYGNUS
WARNER
HYDRA
LYRA
LEO
MENSA
PEGASUS
ORION
PERSEUS
PISCES
SCULPTOR
TAURUS
VELA
SEABROOKE
HERCULES
FALCON
ALBATROSS
PORT ROYAL
RAE RD
FLORIDA
WARAMBI
MALIBU
WYOLA
FROME
WILLMOTT
BRADBURY
MERCHANT
HERBERT
NORTON
KYSON
MERLIN
HAMELIN
MATAITAI
TANGAROA
ROTOMINE
SOLQUEST
MARINER
VOYAGER
FLANORA
CAMBRIDGE
BREADEN
RAESIDE
GRANGE
MURCHISON
NELSON
GASCOYNE
NAGEERU
CARNEGIE
GREY
FITZROY
FORTESCUE
ASHBURTON
MACKAY
RASONI
WOORAMEL
MOORE
POLICE STATION
POST OFFICE
TRAFFIC FLOW
FOR COMPREHENSIVE
Map 127

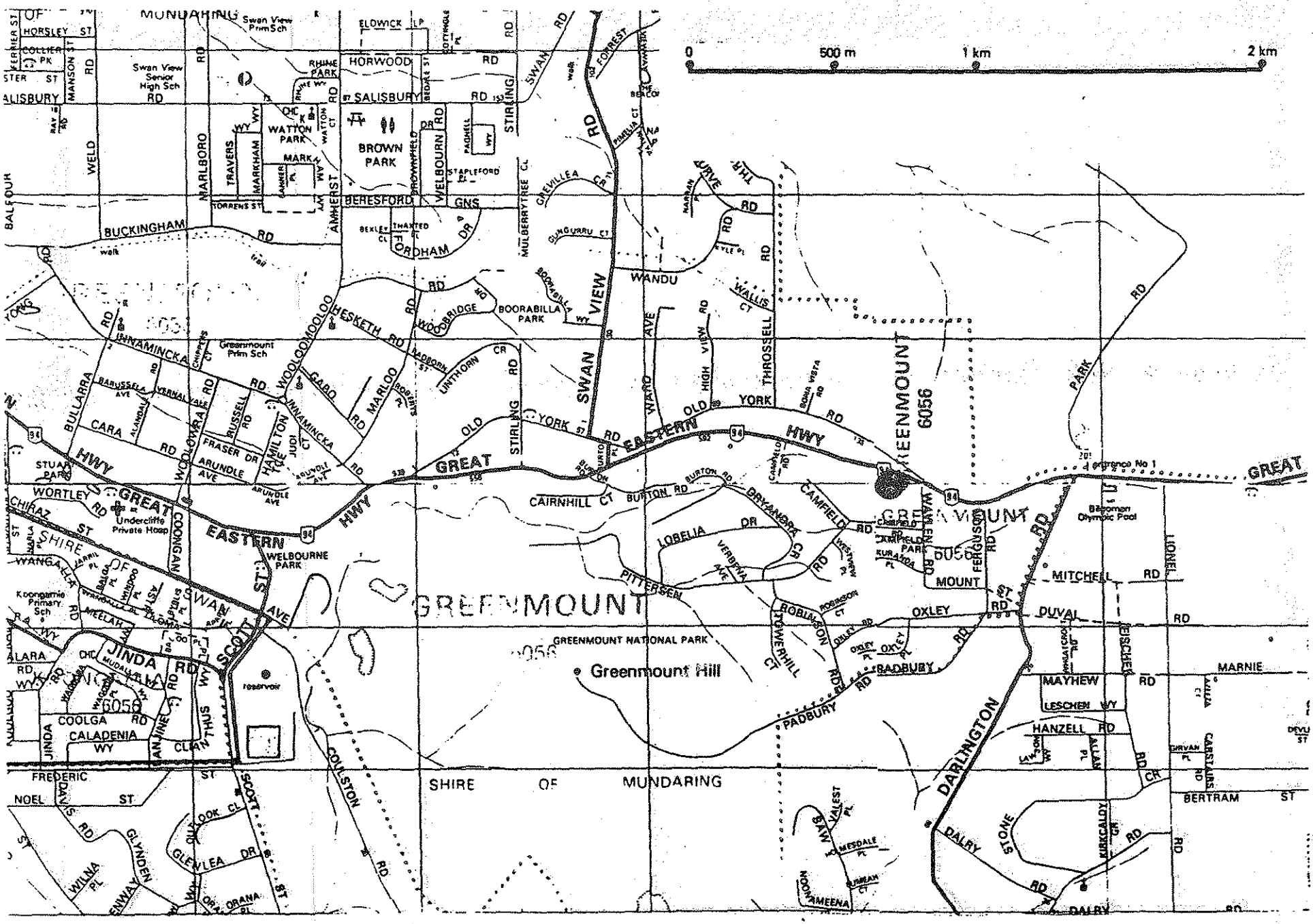

NOISE LEVEL dB(A)
59
57
55
53
51
49
47
45
43
41
39
37
35
33
31
29
27
25
0000
0200
0400
0600
0800
1000
1200
1400
1600
1800
2000
2200
2400
TIME OF DAY (HOURS)
A
B
C
EATON
A SHEPPERTON ROAD, VICTORIA PARK
B GREAT EASTERN HWY GREENMOUNT
C BRENDON WAY, KARRINUP

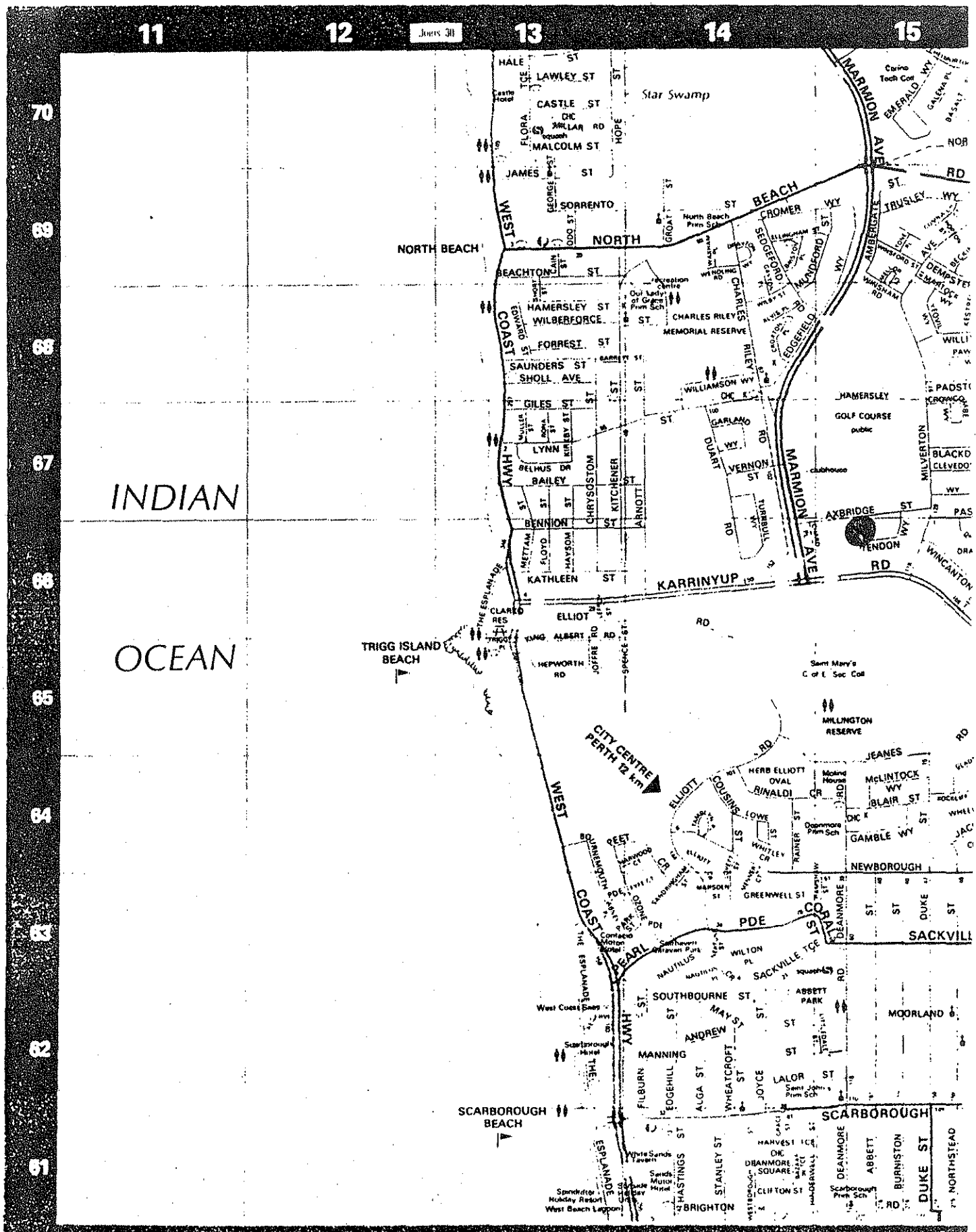


Map 74

0 500 m 1 km 2 km

PRIMARY RECTANGLE
PERTH BG 34


0
500 m
1 km
2 km
MUNDARING
Swan View Prim Sch
ELDWICK LP
HORWOOD RD
RHINE PARK
Swan View Senior High Sch
SALISBURY RD
WATTON PARK
BROWN PARK
STAPLEFORD PL
BERESFORD GNS
BUCKINGHAM RD
FORDHAM DR
BOORABILLA PARK
WANDU
WOOLCOMOOLOO
BRESKETH RD
INNAMINCKA
Greenmount Prim Sch
BULLARRA
CARA RD
HAMILTON
FRASER DR
ARUNDLE AVE
STUART PARK
WORTLEY RD
Undercliffe Private Hosp
CHIRAZ ST
COONGAN
WELBOURNE PARK
SHIRE OF SWAN
Koongamia Primary Sch
JINDA RD
COOLGA RD
CALADENIA WY
ANJINE CL
CLANTHUS WY
reservoir
SCOTT ST
COLLSTON RD
FREDERIC ST
NOEL ST
DAVIS RD
GLYNDEN
WILNA PL
GLENLEA DR
OUTLOOK CL
ORANA PL
STIRLING RD
SWAN VIEW
WARD AVE
HIGH VIEW RD
THROSSELL RD
WALLIS CT
YORK RD
OLD YORK RD
EASTERN HWY
GREAT EASTERN HWY
CAIRNHILL CT
BURTON RD
BRYANDRA CR
CAMFIELD RD
LOBELIA DR
VERBENA AVE
PITTERSEM
GREENMOUNT
GREENMOUNT NATIONAL PARK
Greenmount Hill
ROBINSON
TOWERHILL CT
OXLEY RD
BADBURY RD
PADBURY RD
WAMEN RD
FERGUSON RD
MOUNT ST
MITCHELL RD
DUVAL RD
LESCHEN
MARNIE
MAYHEW RD
HANZELL RD
DARLINGTON
DALRY RD
STONE
KIRKCALDY RD
BERTRAM ST
CARSTAIRS RD
SHIRE OF MUNDARING
Entrance No 1
Bilgoman Olympic Pool
6056



Map 44

PRIMARY RECTANGLE
PERTH RG 24